EXPANDED METAL

AND ITS USES IN

FIRE-PROOF CONSTRUCTIONS.

THE EXPANDED METAL CO., LTD.

(PATENTEES AND MANUFACTURERS.)

HEAD OFFICE:
39, UPPER THAMES STREET,
LONDON, E.C.

TELEGRAPHIC ADDRESS:
"DISTEND, LONDON."
TELEPHONE NO. 1,829.

British Works:

WEST HARTLEPOOL, DURHAM.

N.B.—"Expanded Metal" is patented in the United Kingdom, Europe, and throughout the principal countries of the world.

LONDON.
1897.

SOME PARTICULARS CONCERNING

"EXPANDED METAL,"

ITS PRODUCTION AND USES IN

FIRE-PROOF AND OTHER BUILDING CONSTRUCTIONS.

ALSO FOR

AGRICULTURAL, FARMING, HORTICULTURAL, HARDWARE, AND LIKE PURPOSES.

FURTHER EMBRACING SOME EXTRACTS FROM

Reports, Tests, Opinions, Tables, &c.,

RELATING TO

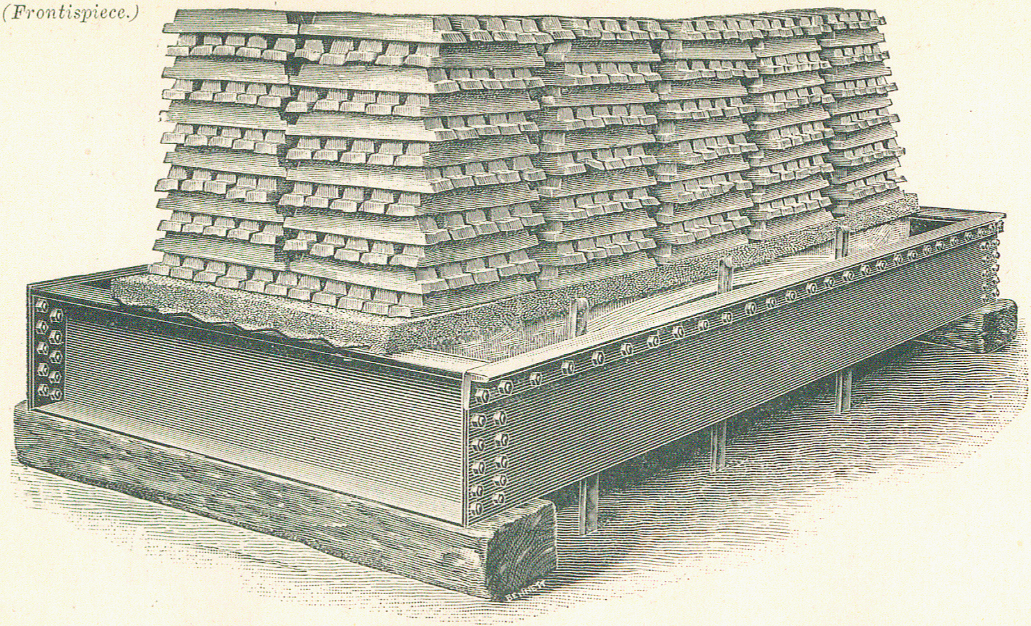
THE EMPLOYMENT OF THE METAL FOR STRUCTURAL PURPOSES.

THE EXPANDED METAL CO., LIMITED,

39, UPPER THAMES STREET, LONDON, E.C.

1897.

(*Frontispiece.*)



CONCRETE AND EXPANDED METAL FLOOR UNDER TEST AT MANCHESTER. JANUARY 11TH, 1897. AVERAGE DEAD WEIGHT, 35 LBS. PER FOOT SUPER. SPAN OF FLOOR ARCHES, 12 FEET; WIDTH APART, 4 FEET; THICKNESS OF FLOOR, 3 INCHES. ULTIMATE STRENGTH FULLY 17 CWT. PER SQUARE FOOT. (FOR FULL DESCRIPTION, SEE PAGE *17*.)

CONTENTS.

"EXPANDED METAL,"

ITS PRODUCTION AND APPLICATIONS.

INTRODUCTORY.

Amongst the annals of modern inventive achievements, probably nothing of the kind is more redundant with features of originality, ingenuity, and utility than Mr. J. F. Golding's remarkable invention of "expanding" sheets, or plates, of various metals into lattice or mesh work.*

Like most valuable inventions of absolutely novel descriptions, many improvements have been made in the production since its first appearance some few years ago. Its development has been, as usual, a process of gradual evolution, so that the material, as now produced, has not only been vastly improved and reduced in cost, but its scope of usefulness has been in the meantime largely extended in numerous directions.

Within the comparatively brief space of five years "Expanded Metal" has attained wide employment, or recognition as an important commercial product, throughout this kingdom and our colonies, as well as in various parts of Europe and throughout the United States of America.

The simplicity and efficiency, economical and utilitarian features of this new fabric, will, it is believed, be readily appreciated upon a perusal of the following pages and accompanying illustrations.

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* An excellent illustrated description of this new manufacture and its uses is given in the columns of *Engineering*, of November 13th, 1896.

Briefly, "Expanded Metal" consists of mechanically slit or cut and deployed or opened out sheets of metal, so as to produce trellis or net-like work, having diamond-shaped meshes and strands of, practically, any desired sizes and thicknesses.

Upon reference to Fig. 1 it will be understood that this ingenious process of extending metal results in a product of greater surface or covering area than that originally possessed by the sheet operated upon—**without any waste of material.**

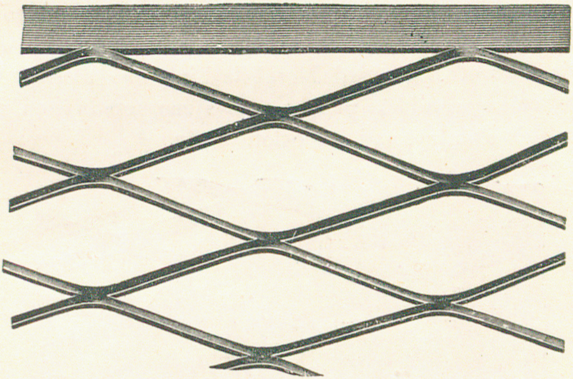


FIG. 1.

The solid sheets of metal to be treated, whether of steel, iron, copper, brass, aluminium, &c., may be of any convenient widths, and the expansion subsequently effected is from **two to twelve times the original breadth of the sheets,** according to the size of the meshes and depth of the strands formed. **This distension is achieved without any diminution of weight or reduction in the original lengths** (or breadths) of the sheets, this remarkable result being obtained by the stretching action to which the strands are subjected during their formation in the machine.

In practice, the sheets employed, or treated, usually range from 24 B.W.G. to $\frac{1}{4}$-in. plate, and the chief metal expanded, or that at present most in demand, is mild steel.

As each mesh is formed of independent solid strands, it will be apparent that a sheet of Expanded Metal may be cut according to requirements without materially reducing its aggregate strength for a given area.

In the illustration a portion of the solid plate is shown left uncut, so as to form a strong selvage edge particularly suitable for the construction of fences or like structures.

Fig. 2 represents a piece of expanded steel, with comparatively small-sized meshes, applied as **a superior substitute for common lathing**, and attention is directed to the excellent manner in which the plaster or cement is embedded and keyed in the metallic lattice work. An enormous quantity of this class of Expanded Metal lathing has already been used for ceilings and like plaster work structures in the United States, this country, and our colonies, &c.

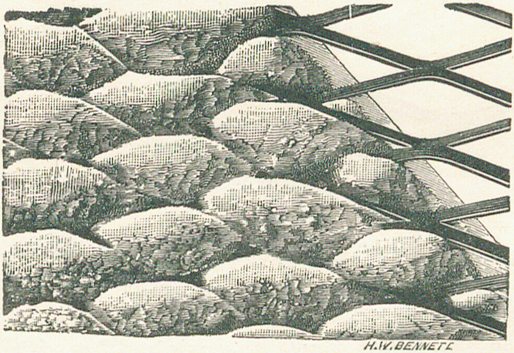


FIG. 2.

When it had been ascertained, or practically demonstrated, that the introduction of heavier **expanded steel into slabs of concrete greatly multiplied the strength** of the latter it was speedily accepted as a most valuable adjunct in fire-resisting constructions of various types.

Owing to the component strands all being formed in an angular relation to the original surface plane of the sheet, it

will be appreciated that the locking of the concrete or plaster within the meshes is most efficiently achieved.

For the construction of fire-resisting, sound or vermin-proof floors and partitions, the employment of Expanded Metal, in combination with concrete, cement, or plaster, has, after crucial tests and experience, proved of incontestable value, and especially so where the strength and lightness of such structures have been duly considered as well as prime cost. Indeed, as a material for building constructions of various kinds, the use, or adaptability, of Expanded Metal is confidently submitted as presenting features of unique interest, utility, and merit.

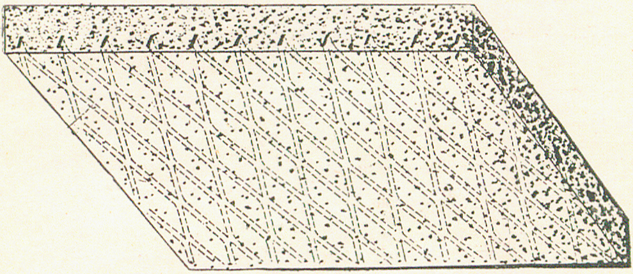


FIG. 3.

Fig. 3 represents a slab of concrete, into which Expanded Metal has been introduced on the lower surface, as shown, so as to constitute **a cheap and efficient "binder" and tension bond**. This combination is particularly useful for the construction of concrete buildings and walls, as also for flooring, paving, and numerous other like purposes in which great strength is required for the employment of a minimum weight of material. The continuity of this constraining metal work is effected by slightly over-lapping the sheets, the joints becoming firmly secured when the concrete filling has thoroughly set. It has been demonstrated by actual tests, or experiments, that such insertion of Expanded Metal has **increased the strength of concrete structures fully tenfold**.

Further, as a cheap, strong, efficient, and ornamental **substitute for innumerable descriptions of wire=work,** "Expanded Metal" has found a wide scope of useful application and approval—*e.g.*, for various classes, or types, of fencing, balustrading, window and other guards, and gate structures; for manifold agricultural, horticultural, and stock-keepers' requirements; as well as for countless economical and artistic purposes in the hardware, &c., trades.

Expanded Metal is manufactured in sheets, up to 8 ft. square, amongst which the following sizes of meshes, and gauges of strands find common employment:—

No.						
14.—6	in.	mesh,	$\frac{3}{16}$ in.	by	$\frac{1}{8}$ in.	metal
12.—6	in.	,,	$\frac{1}{4}$ in.	by	$\frac{1}{8}$ in.	,,
13.—6	in.	,,	$\frac{1}{4}$ in.	by	$\frac{3}{16}$ in.	,,
15.—3	in.	,,	$\frac{1}{8}$ in.	by	$\frac{1}{8}$ in.	,,
7.—3	in.	,,	$\frac{1}{4}$ in.	by	$\frac{1}{16}$ in.	,,
9.—3	in.	,,	$\frac{3}{16}$ in.	by	$\frac{1}{8}$ in.	,,
8.—3	in.	,,	$\frac{1}{4}$ in.	by	$\frac{1}{8}$ in.	,,
11.—3	in.	,,	$\frac{3}{16}$ in.	by	$\frac{3}{16}$ in.	,,
10.—3	in.	,,	$\frac{1}{4}$ in.	by	$\frac{3}{16}$ in.	,,
2.— $\frac{3}{8}$	in.	,,	$\frac{3}{32}$ in.	by	18 BWG.	,,
3.— $\frac{3}{4}$	in.	,,	$\frac{3}{32}$ in.	by	20 ,,	,,
4 — $\frac{3}{4}$	in.	,,	$\frac{3}{32}$ in.	by	16 ,,	,,
6 —$1\frac{1}{2}$	in.	,,	$\frac{1}{8}$ in.	by	16 ,,	,,
5.—$1\frac{1}{2}$	in.	,,	$\frac{3}{32}$ in.	by	18 ,,	,,
1.— $\frac{3}{8}$	in.	,,	$\frac{3}{32}$ in.	by	24 ,,	for lathing

Customers should specify whether the lengths of the sheets required are to be measured lengthwise of the meshes or across the same.

"EXPANDED METAL" IN FIRE-RESISTING BUILDING CONSTRUCTIONS.

FLOORS AND CEILINGS.

The annual sacrifice of lives and valuable properties within our metropolis, cities, and densely populated centres by conflagrations is admittedly something appalling. Still we continue to erect numerous dwellings and buildings in our midst, which, from the employment of wood or other combustible materials of construction, appear to be veritably designed to facilitate their destruction through the inevitable raids of fire. Surely the time cannot be far distant when the exclusive use of fire-resisting materials of construction will be made compulsory in most of our buildings, similar to the municipal exactions instituted in many cities of the United States.

The chief points to be attained in the construction of fire-proof or resisting floors and structures are manifestly strength, lightness, efficiency, and reasonable cost. If every item of cost were carefully considered, it would often be found that a large proportion of the structural expense of buildings lies in the dead weight carried. This is of itself obviously undesirable both as to space occupied and expense necessitated. The skeleton steel frame system for buildings, as inaugurated in the United States, was the natural development of such requirements, and with it came the "veneer wall," with its thin facing of stone, terra-cotta, or brickwork. In some buildings of considerable dimensions on the old style, the total loads due to the weight of floors often exceed those due to the walls. Considering the additional weight of girders, and the columns commonly incident to the old style of floor construction, it seems evident that vast improvements may be made in many so-called modern buildings.

Concrete, properly made, and composed of Portland or other cement, broken coke, slag, clinkers, bricks, or sand, and water, combined in definite known proportions, presents, when set and hardened, such excellent qualities for such structures, that it stands, in its peculiar field, practically unrivalled. The employment of concrete for floors in large public buildings and warehouses has been a practice of long duration, and many publications on the subject record most satisfactory and even wonderful results. The use of a richer concrete or cement at the bottom of the slab, in order to give the floor greater tensile strength, has, however, proved useless in practice. The object desired to be attained cannot be arrived at by such means. The introduction of metal into the lower part of a concrete slab forms a sound and consistent construction for such purpose. Steel, when embedded in concrete, is practically imperishable. The cohesion between steel and concrete is thoroughly satisfactory. Concrete is admittedly an excellent material used in compression. With the union, or combination, of concrete and Expanded Metal, a floor may be constructed of greater strength and fire-resisting efficiency, and yet be of unusual lightness.

The employment of good cement is obviously necessary, and of all the class "Portland" is the most valuable, and compared strength for strength, it is the cheapest and best to use.

The "aggregate" should be clean, sharp and free from all earthy matter.

The use of broken stone, firebricks, &c., forms a strong concrete, but it also produces a mass of considerable weight. Cinder or coke breeze concrete is nearly one-half of the weight of the stone aggregate, and possesses practically as good fire-resisting properties.

The thickness of the concrete slab in which the Expanded Metal is embedded varies, and is obviously dependent upon the areas between the beams or joists, and the loads to be carried. **A slab of 3 in. thickness is sufficient for most floors.** In these slabs of concrete the metal is completely

embedded, and as the mixture is thoroughly tamped or rammed down the resulting mass is solid and leaves no chance of the metal corroding. Under these conditions the full value of the floor is achieved.

Where the joists are placed wider apart, or the loads to be carried are heavier, a substructure of concrete and channel iron arches should be employed to carry the flooring slab. It will be evident that the various principles or examples of construction given in the following pages are subject to some modification as occasion may require.

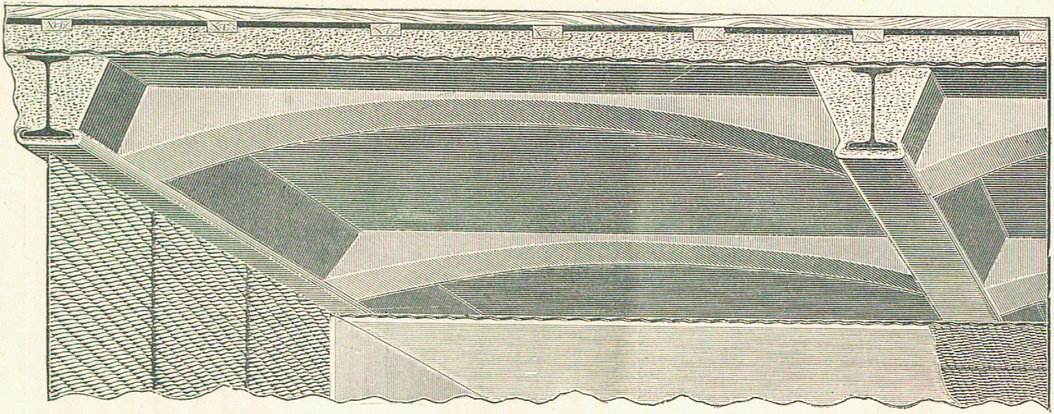
For an irrefutable corroboration of the remarkable manner in which the introduction of Expanded Metal into concrete structures increases the strengths of the same, we refer the reader to some extracts taken from Sir John Fowler's and Sir Benjamin Baker's (Past Presidents of the Institution of Civil Engineers) recent Report thereon, a copy of which may be had on application to the Company.* The practical experiences therein recorded by these pre-eminent engineers are to the effect:—"That the use of **Expanded Metal**, in the case of a 3 ft. 6 in. span, **increases the strength** of a flat concrete slab **from 6 to 8 times** the strength for carrying an uniform load that it would have if made without the metal; and in the case of a **6 ft. 6 in.** span, the **strength is increased to 10 and 11 times.**"

Further, "as regards strength, the slabs made without Expanded Metal did not approach those made with the metal, and that even with a **neat cement-slab,** the **strength was much inferior.**"

According to this Report, the use of a neat cement slab, (which cost as much as that in which Expanded Metal was employed) only showed an augmentation of from twice to three times the strength, as compared with the 3 to 1 mixture, whereas the **introduction of Expanded Metal enhanced the strength from eight to eleven fold.**

* Architects and Engineers are cordially invited to send for a copy of this report.

SYSTEM I.



This tersely explains the very essence and salient advantage of our system of fire-resisting floors and constructions—viz., **the achievement of unique strength for a minimum weight of structure.** A useful tabulation, based on the above report, will be found at the close of this dissertation, which conveys at a glance some examples of the strengths of flooring slabs of various spans when constructed according to our method.

System No. 1.—This illustration represents a design which is applicable to many classes of buildings, in which considerable strength of flooring is required. It may be used with a variety of

metal-framings by virtue of the introduction of arched channels.

This system has been successfully adopted in many important buildings with spans of 8 to 16 ft., and the arches 4 ft. to 5 ft. apart. Those indicated are formed of curved steel channels 5 ins. to 6 ins. in width, weighing from 8 to 12 pounds per foot, but the weights may be varied according to requirements. Upon these the concrete is built up to the floor level. The floors can be made to sustain any desired loads by simply increasing or diminishing the number of the concrete arches or weight of the steel channels. Attention is directed to the efficient manner in which all the metal work is encased in, and protected by, the concrete. As a sound and economical construction of floor for warehouses, mills, factories, &c., it cannot be excelled.

A meritorious feature claimed for our systems of floor construction is their ready adaptability to varying conditions and circumstances, as will be seen from the following illustrations. We are prepared to design and estimate for a large variety of floors and iron or steel framings, and we can secure practically any desired result as to strength or style of finish, whether with flat ceiling, segmental, arch, or panel effects. All of the systems shown have been actually constructed with satisfactory results.

After placing the centering in position, the Expanded Metal, of 3 in. mesh, is laid down, the sheets of material, say, 8 ft. by 4 ft., being placed **lengthwise** across the beams or girders and **overlapped** at the sides and ends. The concrete mixture is then spread over the surface and thoroughly tamped down. This process results in the metal becoming secured or **embedded** in the lower part of the slab, thereby leaving a smooth underneath surface when the centering is removed.

Such details of practice will vary with our different systems, according to requirements, as will be apparent from the illustrations. The economy, as well as questions of

desired strength and weight, must be calculated for each case presented.

The full value of these systems from an economic standpoint is not accomplished without the use of special iron or steel framings in accordance with the particular needs. The weight of our floors is so much less than heavy tile blocks or other bulky methods of construction, that **a great economy is possible in the metallic part of the structure.** The weight of the concrete slabs constituting **the floor need not exceed an average of from 25 lbs. to 30 lbs. per square foot,** according to our systems of construction. It is submitted that designing architects and engineers should take this factor into their considerations when plans are being prepared or submitted for estimates.

The series of illustrations given on **Plate A** (see next page) clearly represent the method of erection adopted in the construction of our fire-resisting concrete floors when carried upon arched channel ribs. Upon reference to the descriptive notes which appear on the drawings, but little further explanation will be necessary. The illustrations graphically indicate the forms and arrangements of the steel joists and curved channel framings, the weights and spans of which will vary according to the loads to be carried and other requirements. The arrangements and functions of the temporary centering or lagging boards, by which the concrete arches and flooring are formed, will be apparent from the drawings and notes thereon. The manner in which the concrete filling is used to build up the arches upon the curved channel irons, by its insertion between template boards or wooden cheeks, will be equally evident. The Expanded Metal sheets are shown as directly and horizontally laid across the top flanges of the girders (lengthwise of mesh) and the finished level of the concrete arches; upon these sheets the concrete floor is laid as before described and as illustrated in the accompanying plate. Attention is directed to the uniform and continuous nature of the finished structure thus formed,

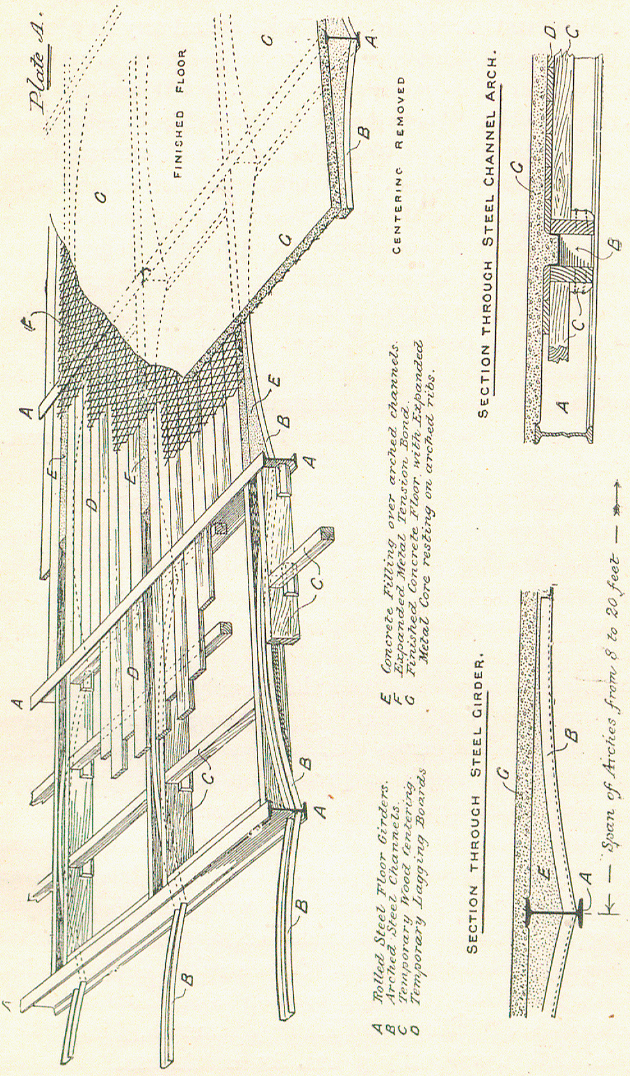


Plate A.
FINISHED FLOOR
CENTERING REMOVED
A Rolled Steel Floor Girders.
B Arched Steel Channels.
C Temporary Wood Centering.
D Temporary Lagging Boards
E Concrete Filling over arched channels.
F Expanded Metal Tension Bond.
G Finished Concrete Floor with Expanded Metal Core resting on arched ribs.
SECTION THROUGH STEEL CHANNEL ARCH.
SECTION THROUGH STEEL GIRDER.
Span of Arches from 8 to 20 feet

PLATE A.

In practice, fire-resisting floors of this description may be effectually **constructed so as to withstand any live loads** up to about 20 cwt. per superficial foot; the distances between the arches and joists may be from 4 ft. to 7 ft. and 10 ft. to 18 ft. respectively. The average **dead weight** of such a floor, with its concrete supporting ribs, **need not exceed from 35 lbs. to 40 lbs. per sq. ft.,** whilst the cost of same will favourably compare with any other known systems of construction when the stability, strength and comparative structural lightness of our system are duly considered.

An ultimate floor strength of about a ton to the square foot is manifestly in excess of most practical requirements, indeed, after allowing a factor of safety of four times the aggregate theoretical load, the **ultimate resistance** required for a factory or warehouse floor **rarely exceeds 15 cwt. per foot.**

When the load to be carried is lighter, the span of the channel arches may be safely extended to fully 20 ft. and upwards. By increasing the depth or sectional strength of the channel arches, it will be apparent that very heavy loads may be sustained or unusually large spans securely effected.

The illustration which forms the *frontispiece* to this handbook represents one section of our long span (arch-supported) floors as under test at Manchester on January 11th, 1897. The engraving is a reproduction from a photograph which was taken during the trial, when the floor was in an advanced stage of loading, or when about 12 cwts. to the sq. ft. had been applied. The side plates, shown bolted to the girders, were employed with the object of preventing any lateral displacement of the joists from the thrust of the channel arches. The area of this test floor was 48 square feet, and the concrete slab, containing the embedded sheet of Expanded Metal (3 in. mesh, $\frac{1}{4}$ in. strands by $\frac{1}{8}$ in. metal), was **only 3 ins. in thickness.** The concrete was composed of 1 part of Portland cement to 3 parts

of granite chippings. The weight of the inserted metal averaged less than 1 lb. per square foot. The channel arches were placed 4 ft. apart, and the joists 12 ft. from centre to centre. The **total weight of the floor,** including its supporting ribs, **averaged 35 lbs. per foot** super., whilst **the aggregate live load sustained before rupture was nearly 17 cwt. per square foot,** and with this great strain it would not have collapsed had not the tie-rod parted. The remarkable merits and strength of this structure, when its span and lightness are considered, will be found accentuated in the following extracts taken from the Press :—

"THE ENGINEER," *January 15th, 1897.*

"A party of about a hundred witnessed the experiments, the attendance including many of the leading engineers and architects of the district, together with press representatives. The first test made was with a long span floor arch on the Golding Expanded Metal system. This was constructed of channel irons curved to form arches, which were set in between main girders 12 ft. apart, the ends of which were held by plates. The channels were about 4 ft. apart, the arches being filled with concrete, whilst across them was placed the Expanded Metal. On this metal 3 ins. of concrete was placed, making a flat floor between the curved channels of the above thickness. The floor was 12 ft. long on the arch and 4 ft. wide. The breaking strain was tested by means of lead ingots weighing 100 lbs. each, which were gradually piled up in separate stacks, covering the whole of the floor area. The floor did not give way until nearly 17 cwts. per square foot had been placed upon it. At this point the tie-rods which were holding the main girders together broke, after which the deflection from the centre of the main girders allowed the arches to sink, and the floor gradually settled. The second test was with an arch on the Monier system, in which, however, Expanded Metal was employed in place of the ordinary rods. This arch was of concrete, 3 ins. thick at the crown and 4 ins. at the abutments, with a length of 12 ft. and a width of 4 ft. The Expanded Metal was laid on the curved centering, which had a rise of 13 ins. in 12 ft., and the concrete was placed over the metal. The test was applied by lead ingots, as in the first instance, and the arch did not break until 12 cwts. per square foot had been placed above it. We understand that in this case, considering that the concrete

was only a month old, and made in the frosty weather of December, the results obtained were 8 per cent. better than those secured by Monier rods, with the same class of concrete made in the summer, and having stood for three months. The experiments generally demonstrated a superiority on the part of the Golding system.

"Notwithstanding the conditions of the tests, which were not nearly so favourable as would have been the case in an actual building, the snapping of the tie-rods being practically the chief cause which contributed to the giving way of the arches, the results were in every way satisfactory, the pressure sustained being far in excess of any weight likely to be experienced in actual use, whilst the exceptional lightness of the structures is a feature also to be borne in mind.

"ENGINEERING," *January 15th, 1897.*

"The result was that whereas the arched (Monier) floor collapsed under a load equivalent to 12 cwt. per square foot, the Golding floor (exhibit 1) was still unbroken at the close of the experiments by a load of nearly 17 cwt. to the square foot. These experiments were undertaken in connection with the flooring contracts for the New Brighton Tower. The structures were erected by Mr. Hamor Lockwood, of Manchester, the tests being conducted in the presence of a representative of Messrs. Maxwell and Tuke, of the same city, who are the architects to the tower. The employment of 'Expanded Metal' in these test constructions gave every satisfaction, and in the second case, in which it had been substituted for Monier rods, the gain in strength was nearly 9 per cent., beside advantages in economy. In both instances there was, unfortunately, some lateral displacement of the joists through the thrusting actions of the loaded arches, which, to some extent, unquestionably impaired the ultimate efficiency of the test-pieces of flooring."

"THE BUILDER," *January 15th, 1897.*

"It is clear that both floors attained great strength with a remarkably small quantity of the metal, a further proof—if such were needed—of the extravagant waste of metal in most of the systems of fire-resisting floor-construction now in use in England. The tests made last year by Sir John Fowler and Sir Benjamin Baker—which we hope to record when we comment on this week's tests — show beyond question the enormous accession of strength gained in concrete slabs by the insertion of Expanded Metal."

"THE ARCHITECT," *January 16th, 1897.*

"It was known for some time that the introduction of Golding's Expanded Metal in concrete, cement, or other material not only increased the strength of that material, but also its fire-resisting qualities. Hence partitions, ceilings, floors and walls are improved without any extraordinary outlay. In order to demonstrate again how much endurance is possessed by floors of which the Expanded Metal forms an element, some remarkable tests were applied in the presence of architects, engineers, and other experts, on Monday last, at Mr. Lockwood's yard in Sackville Street, Manchester."

"THE MANCHESTER NEWS," *January 23rd, 1897.*

"The test of strength at the experimental trial in Sackville Street was made with an arch twelve feet span by four feet wide, fixed between firm abutments, with a rise of twelve inches in the centre. The arch was formed by two curved steel girders filled with concrete, over which was laid a straight slab covering the whole space, about three inches thick, in the middle of which was embedded the expanded steel network. The extraordinary lightness of the structure and its great strength may be gathered from the fact that whilst its weight per superficial foot was only thirty-five pounds, the arch did not give way until over forty tons of lead ingots had been piled upon it, equal to seventeen hundredweight per square foot. The test from beginning to end was something in the nature of a revelation to the gentlemen who had been invited to witness the trial, including several leading architects, builders, and civil engineers. The idea of this novel application of steel to structural work was broached in America some six years ago, but it is only within the last two or three years that the system has been perfected. Like many other ingenious and useful American inventions, our machinists are not slow to appreciate such mechanical appliances, and we are therefore not surprised to know that the latest improved machines of the patentee for producing this curious steel network are being made by Sir Joseph Whitworth and Company, Limited, of this city."

THE SAVING IN TOTAL WEIGHT.

It is not alone the economy in the iron work itself that should be carefully observed in respect of our floor and ceiling constructions, but the opportunity offered for saving in the matter of wall and pier foundations. It has been

established that the **economical advantage in the weight** of our floors and their sustaining frames as compared with heavy metal and tile constructions, **may be equal to some 50 lbs.** per square foot. This reduction of weight in high buildings of many storeys, with large floor areas, obviously amounts to a very considerable aggregate.

SANITARY ADVANTAGES.

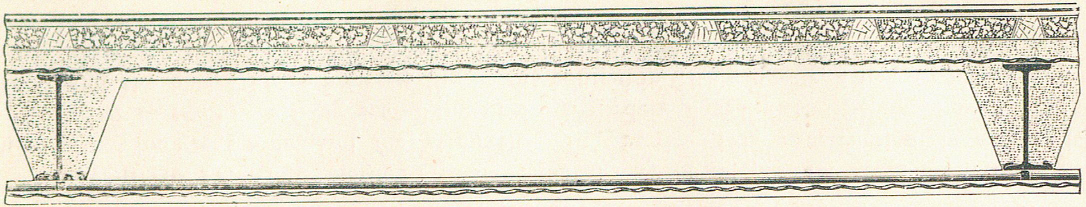
The sanitary or hygienic properties of concrete constructions are too well known to need more than brief recital. A floor constructed on most of our systems is in reality a solid monolith from outer to outer walls. Such openings as may be made in the floor for the passage of pipes and wires, &c., can be hermetically sealed by cement before the final surface finish is executed. This leaves a floor which is **impermeable to moisture, germs, or vermin of any kind**.

Reference may be here made to methods of laying wooden flooring on the concrete. A convenient practice is shown in our illustrations, wherein nailing strips are used, partially embedded in the concrete before it has firmly set. This method leaves an **air space of sound-proof qualities.** If desired the wooden flooring may in some cases be nailed directly upon the concrete, and any danger of dry rot can be avoided by applying a hot coat of tar or asphalte to the top of the concrete.

In many classes of buildings wooden floors are quite unnecessary. On the upper surface of the concrete a finishing coat of cement and sand may be laid, or an asphalte finish may be used as occasion may require. For warehouses, factories, hospitals, laundries, &c., this plan of finished floor surface may be adopted with the advantages of cleanliness, sanitation, and freedom from fire risks.

***System* No. II.**—This plan of construction (see next page) may be described as being generally similar to that of No. 1, without the use of the intervening channel arches, and is applicable to floors of moderate strengths, in spans up to

SYSTEM II.



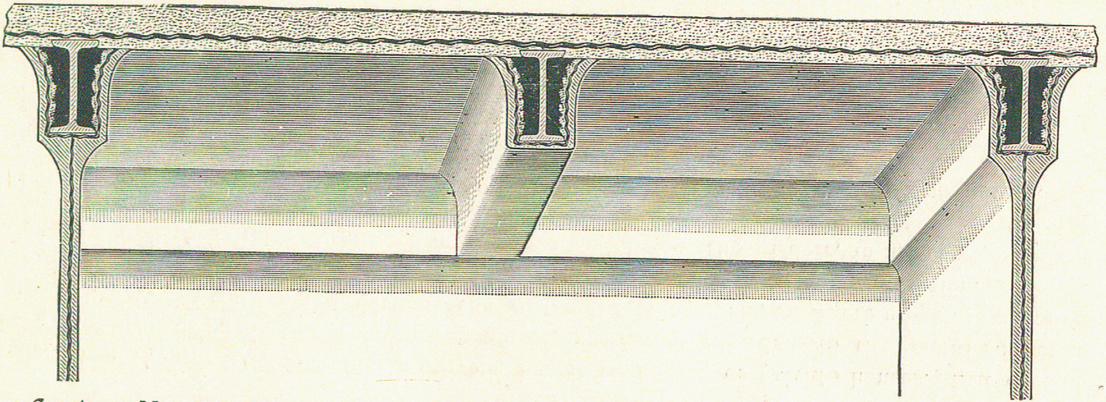
8 ft. between the girders, for offices, schools, hospitals, hotels, or private houses. An excellent feature in this design is the thorough fireproof protection afforded to the metal supporting beams. It may be constructed without the suspended ceiling shown where economy is desired, or where there is no objection to a panel ceiling, as represented in the next illustration.

The serrated black lines shown running above and below the girders, in all cases, represent the application and position of the Expanded Metal sheets.

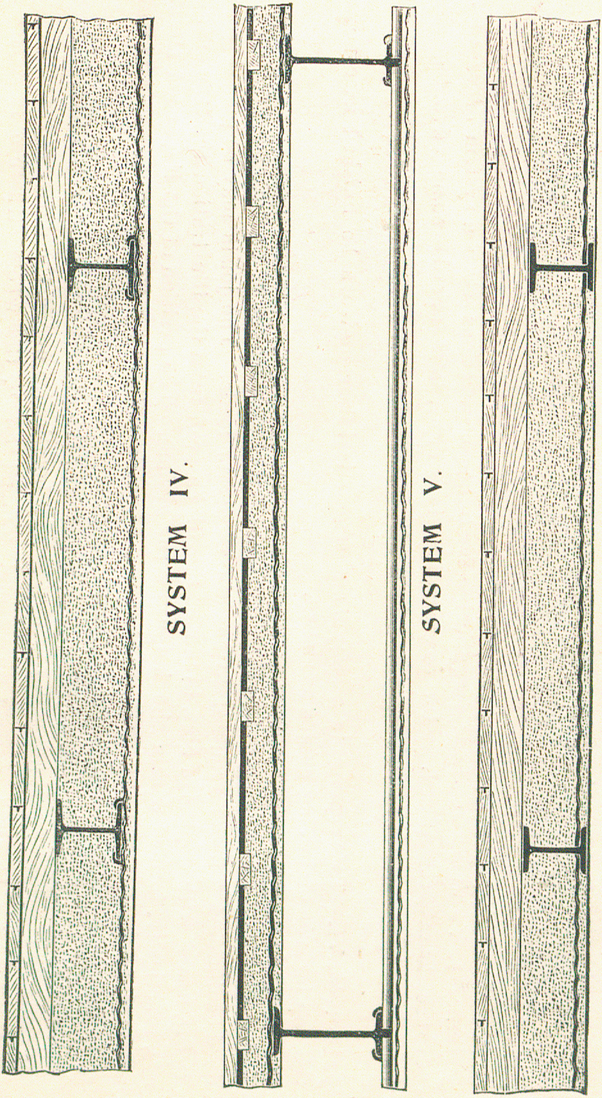
In this example the hanging ceiling is formed of Expanded Metal lathing and plaster, with an air space between the floor and the same.

System No. III.—This illustration (overleaf) represents a panel-finished ceiling with bays on line with the beams or metal joists, which are protected by plaster laid upon Expanded Metal lathing. This form is practical in the erection of dormitories and houses where the live loads are light, and when rooms are of uniform size. By this system only 4 ins. to 5 ins. of the height of a building or room is taken up by the floor, which means a considerable saving of head room. The protection of the beams may be accomplished by modified arrangements if desired.

SYSTEM III.



System No. IV.—This method (see next plate) may be adopted for economy in cases where there is not too great a demand for strength. In practice this construction is accomplished by securing to the lower flanges of 3 ins. or 4 ins. girders placed at short spans, heavy Expanded Metal, and the entire space between the beams is filled in with concrete, 2 ins. wooden floor-strips being laid across them about 2 ft. apart. The ceiling is plastered in the usual way. This arrangement has been used in hospitals and like buildings. A floor of this construction, with 4 ins. joists 10 ft. long and at 4 ft. pitches, has stood fully 300 pounds per foot without deflection.



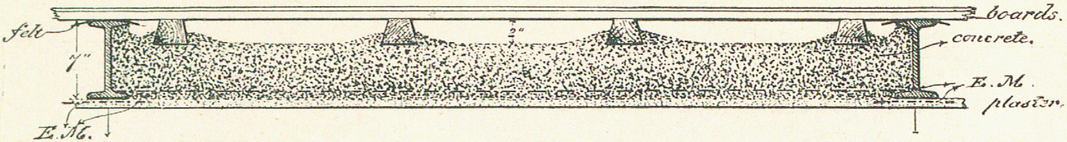
SYSTEM IV.

SYSTEM V.

SYSTEM VI.

(Description, see pages 23 and 25.)

SYSTEM VII.



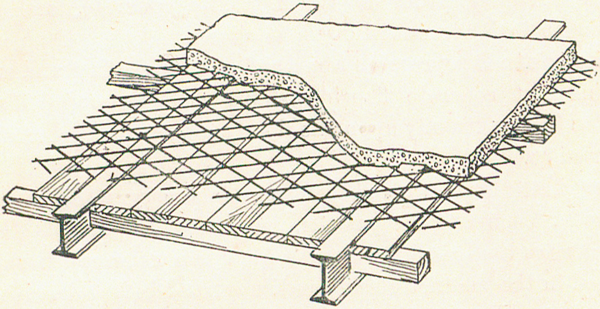
System No. V.—This method is applicable for light constructions when a system of ventilation in the floors is required. Its construction is simple, and affords some advantage in particular cases.

System No. VI.—This represents a simple and economical floor, and can be finished in cement on the top instead of having boards as shown.

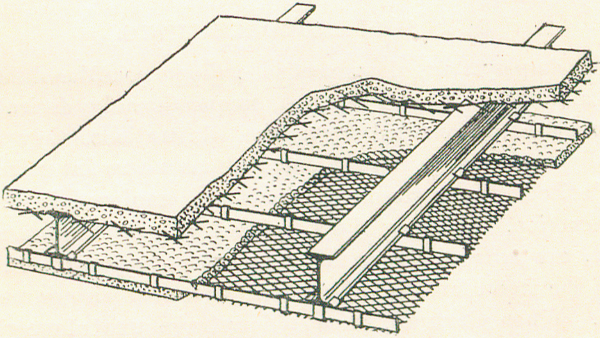
System No. VII.—According to this modification, a light, compact and economical construction is obtained, suitable for floors required to sustain moderate loads. The joists may be placed from 4ft. to 8ft. apart, with depths of 5ins. to 8ins. It will be seen from the illustration that the entire floor is, practically, formed within the height of the girders. The position of the Expanded Metal is indicated by the dotted lines. The construction is, practically, carried out by one operation of filling in the concrete upon common flat centering boards.

The sheet of 3in. mesh Expanded Metal is laid between the girders and upon the bottom flanges of the same, the strips of lathing metal being inserted lengthwise under the latter as represented. When the concrete is filled in from above and tamped down, the whole structure is securely

Plate. B.



Expanded Metal Tension Bond
Coring laid on centering, and
Concrete Floor partly laid.



Suspended Ceiling of plaster
on Expanded Metal lathing under
concrete floor shewing space for
Air Circulation.

PLATE B.

locked together. The wooden flooring strips are partially embedded in the concrete before it has set; later, the plaster ceiling is applied direct to the Expanded Metal and lathing which partially protrude through the concrete, and the flooring boards are nailed down as shown.

The Plate B represents a method of constructing and supporting flat concrete flooring slabs, with Expanded Metal tension bonds, directly upon the floor joists, as just previously referred to.

The first illustration shows the temporary wooden templates or centering in position, with the Expanded Metal laid across the girders, upon which the concrete floor is formed in the manner clearly indicated and before described.

The second engraving represents a portion of a finished flooring slab broken away so as to show the suspended ceiling beneath, which is composed of our metal lathing and plaster, hung from the joists so as to leave an **air space** between the floor and ceiling. Upon reference to the drawings and notes affixed further explanation would be superfluous.

OUR SUSPENDED CEILINGS.

The employment of suspended ceilings, considered from any standpoint, is, we contend, unquestionably desirable. As may be understood from the illustrations, they are usually necessary in most of our systems where flat ceilings are desired. Very simple methods are employed in their construction. Furring bars, placed at short distances apart, are secured by metal clamps to the joists, and to these the metal lathing is fixed with annealed wire or metal clips. When plastered, these ceilings **have a total weight,** including furring bars and plaster, of **about 8 to 10 pounds** per square foot. **The fire-resisting qualities of this construction are very thorough.** It will be seen, by reference to the illustrations, that these ceilings **can be hung at any desired level.** That is, they may be suspended flush with

the beams or girders, or they can be dropped any desired distance below the same in order to accommodate pipes or electric wires, &c. Extensions of these ceilings may be carried to the side walls, in bays or coves of any desired form for obtaining artistic effects. Developments in this class of work have led to the erection of domes, arched halls and alcoves, &c., as referred to later on.

Upon reference to **Plate C** (over leaf) and the descriptive notes thereon, the structural details of these suspended ceilings will be manifest. In these illustrations the joist and lathing attachment clips, also the ceiling bars, to which the sheets of Expanded Metal are secured by the latter, for carrying the plaster work, are all clearly portrayed to an enlarged scale.

Fig 4 represents a method of suspending our flat fire and sound proof ceilings beneath our long span floor arches through the intervention of hanging rod attachments, placed at convenient distances apart, the upper ends of same being secured to the curved channel irons, whilst their lower extremities are connected to the ceiling bars as indicated in the illustration.

According to the modification shown on **Plate F** (see page 36), the ceiling is hung in curved form following the contour or intrados of the arches, the means by which the carrying bars are attached to the curved channel irons and metal

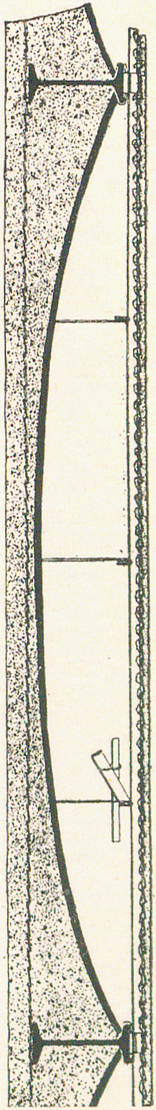


FIG. 4.

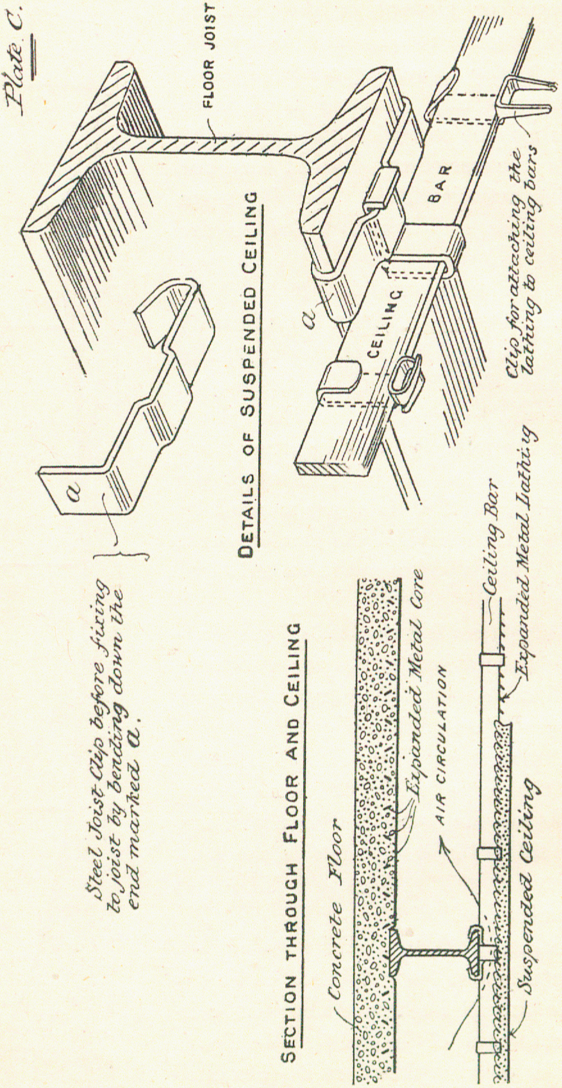


Plate C.
FLOOR JOIST
BAR
CEILING
a
a
Clip for attaching the lathing to ceiling bars
DETAILS OF SUSPENDED CEILING
Steel Joist Clip before fixing to joist by bending down the end marked a.
SECTION THROUGH FLOOR AND CEILING
Concrete Floor
Expanded Metal Core
AIR CIRCULATION
Ceiling Bar
Expanded Metal Lathing
Suspended Ceiling

PLATE C.

lathing, being readily apparent from the descriptions already given and upon reference to the notes which appear on the plate.

In the section the arched floor ribs are shown provided with cantilever tie rods. The Expanded Metal and plaster are represented as following the curvature of the arches and passing under the lower flanges of the joists, an air space being left between the ceiling and the arches, girders and flooring slab, so as to constitute an efficient fire and sound proof construction.

FIRE, SOUND, AND VERMIN PROOF PARTITIONS.

This type of partition was an outgrowth of the invention of Expanded Metal, or an evolution in the process of developing the manifold uses of this excellent lathing material. They were first used in Chicago in 1891, and patents were granted to John F. Golding for the same in various countries throughout the world. This class of partition, as now constructed throughout the United States, consists of vertical channel steels or rods, securely fastened at top and bottom by screws, nails, or iron clamps, as occasion may warrant. These are placed at 12 in. centres, if the height of the ceilings be 10 ft. or more. For ceilings of less than 10 ft., 16 in. apart is quite sufficient. To these supports the Expanded Metal lathing is firmly secured by pieces of soft wire or other like convenient means.

The mortar used for the partitions is of so-called "hard" or "patent plaster," which sets like cement or calcined plaster, by crystallisation. Common mortar of the thickness required would be too long in drying, and will not attain the solid stiffness desired. These partitions are frequently built only 1½ in.

thick, but are sometimes made **2 in. thick for long stretches** or high ceilings. The fastenings used at top and bottom of the vertical supports vary according to the class of work and other requirements. When the plaster has thoroughly set the labour of destruction will far exceed that expended in putting the walls in place, **the finished structure being exceedingly strong and rigid.**

The accompanying **Plates D and E** (next two pages) represent the construction and methods of erecting our solid partitions, composed of Expanded Metal and plaster, as designed for execution in this and other countries.

The first plate refers to their structural details when used in combination with our concrete floors and plaster ceilings, whilst the second page explains their adaptation to ordinary wooden joists and flooring boards. Letters of reference, with corresponding descriptive notes, are affixed to the illustrations. On Plate D the floors, ceiling, and walls being constructed of concrete, plaster and Expanded Metal, are all thoroughly fire, sound, moisture, and vermin proof. The construction and applications of our arched and flat slab floors, with or without the addition of our suspended ceilings, have already been amply described. L represents vertical tension rods, of about $\frac{1}{4}$ in. diameter, which are placed about one foot apart, and secured to the ceiling bars and flooring girders by the agency of metallic clipping devices, as shown. Between these rods single sheets of Expanded Metal M are interlaced, and upon the latter the plaster N is applied in the usual way, the total thickness of the finished partition being usually 2 ins. The method by which the wooden door frame W is secured in position by the staples X embracing the contiguous wall rods L, as well as other details, will be evident upon examining the drawings.

The parts marked E and V represent flooring boards laid upon the concrete floors, with an intermediate packing of asphalted felt or like suitable material. With the exception of the modified method of fixing the partition rods to the

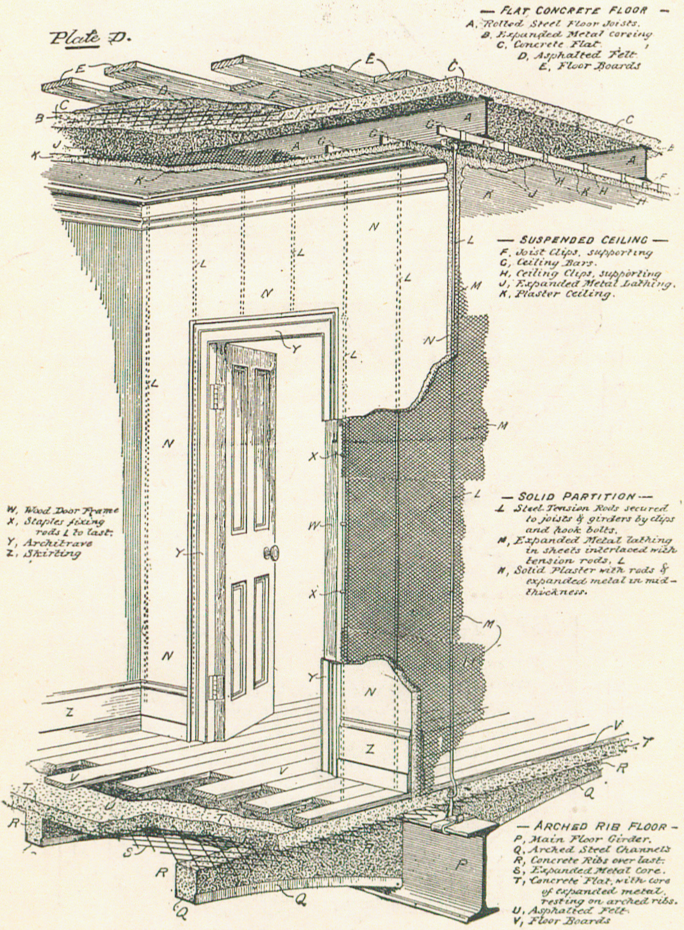


Plate D.
— FLAT CONCRETE FLOOR —
A, Rolled Steel Floor Joists.
B, Expanded Metal coreing
C, Concrete Flat
D, Asphalted Felt
E, Floor Boards
— SUSPENDED CEILING —
F, Joist Clips, supporting
G, Ceiling Bars.
H, Ceiling Clips, supporting
J, Expanded Metal Lathing.
K, Plaster Ceiling.
— SOLID PARTITION —
L Steel Tension Rods secured to joists & girders by clips and hook bolts.
M, Expanded Metal lathing in sheets interlaced with tension rods, L
N, Solid Plaster with rods & expanded metal in mid-thickness.
W, Wood Door Frame
X, Staples fixing rods L to last.
Y, Architrave
Z, Skirting
— ARCHED RIB FLOOR —
P, Main Floor Girder.
Q, Arched Steel Channels
R, Concrete Ribs over last.
S, Expanded Metal core.
T, Concrete Flat, with core of expanded metal, resting on arched ribs.
U, Asphalted Felt
V, Floor Boards

PLATE D.

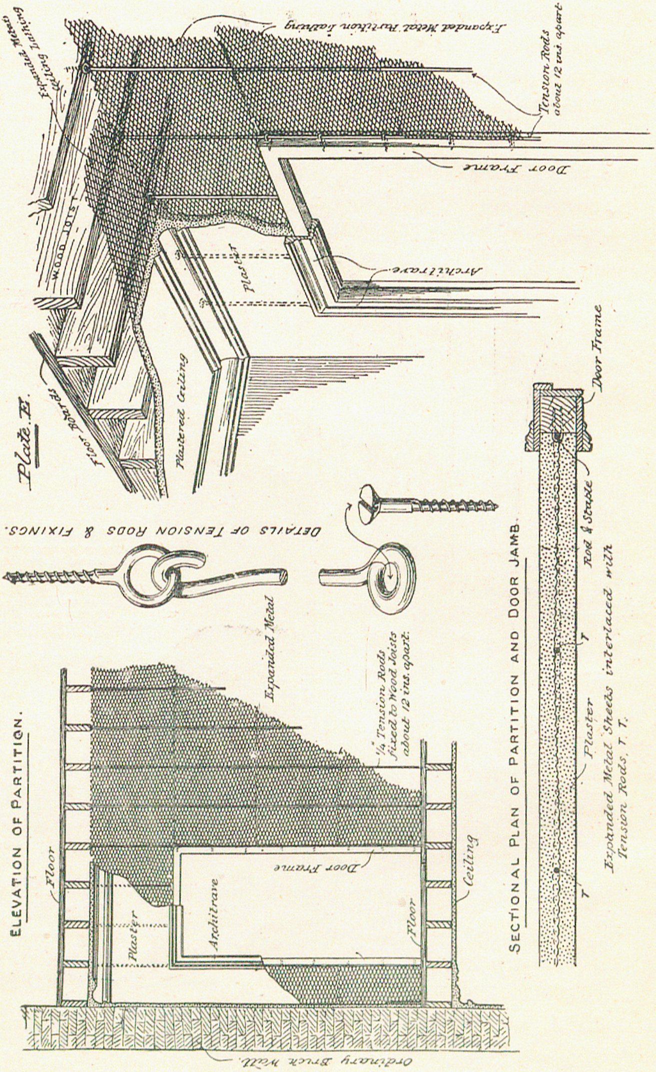


Plate E.
Floor Boards
Wood Joist
Expanded Metal Ceiling Lathing
Expanded Metal Partition Lathing
Tension Rods about 12 ins. apart
Door Frame
Architrave.
Plaster
Plastered Ceiling
DETAILS OF TENSION RODS & FIXINGS.
ELEVATION OF PARTITION.
Floor
Plaster
Architrave
Door Frame
Floor
Ceiling
Expanded Metal
1/4" Tension Rods fixed to Wood Joists about 12 ins. apart.
Ordinary Brick Wall.
SECTIONAL PLAN OF PARTITION AND DOOR JAMB.
Door Frame
Rod & Staple
Plaster
Expanded Metal Sheets interlaced with Tension Rods, T. T.

PLATE E.

wooden joists and floors, the construction shown in plate E is similar to that explained with reference to plate D. An enlarged view of these details of attachment are given in the illustrations ; they consist, as will be seen, of hook and eye terminations to the rods, which are secured to the joists and floor by means of the screw contrivances represented. The section of the wall and door jamb shows the manner in which the vertical supporting rods are connected to the door frame by staples, or like simple devices. In both examples the tension rods which support the metal lathing are provided with screw adjustments so as to render and maintain them taut. Obviously window or other frames may be similarly provided for and fixed when employing our construction of divisional walls, and if desired, the partitions may be of hollow formation in cases where extreme lightness is required, or the rooms to be formed are unusually lofty. In such form, supporting columns can be provided within the partition or the intermediate wall studs, or framing may be arranged so as to assist in carrying the load. If desired, the intermediate spaces may be filled in with slag wool or other fire-resisting and non-conducting material. Evidently the metal lathing can be, if required, readily secured to wooden stud work. In our solid partitions the single sheets of Expanded Metal, interlaced between the tension rods in basket form, constitute the key for plastering up both sides. Any quick and hard-setting cement or plaster may be used for the purpose.

SOME MERITS OF THESE WALLS.

This form of partition possesses all the desired advantages of a divisional wall, and occupies the least possible space for such a purpose. It is thoroughly fire-proof and impervious to moisture, germs, noxious insects, mice, or like animal pests. **In lightness it is all that can be required,** as it only weighs some 20 pounds per square foot complete, including metal and plaster. **In strength it may be said to be**

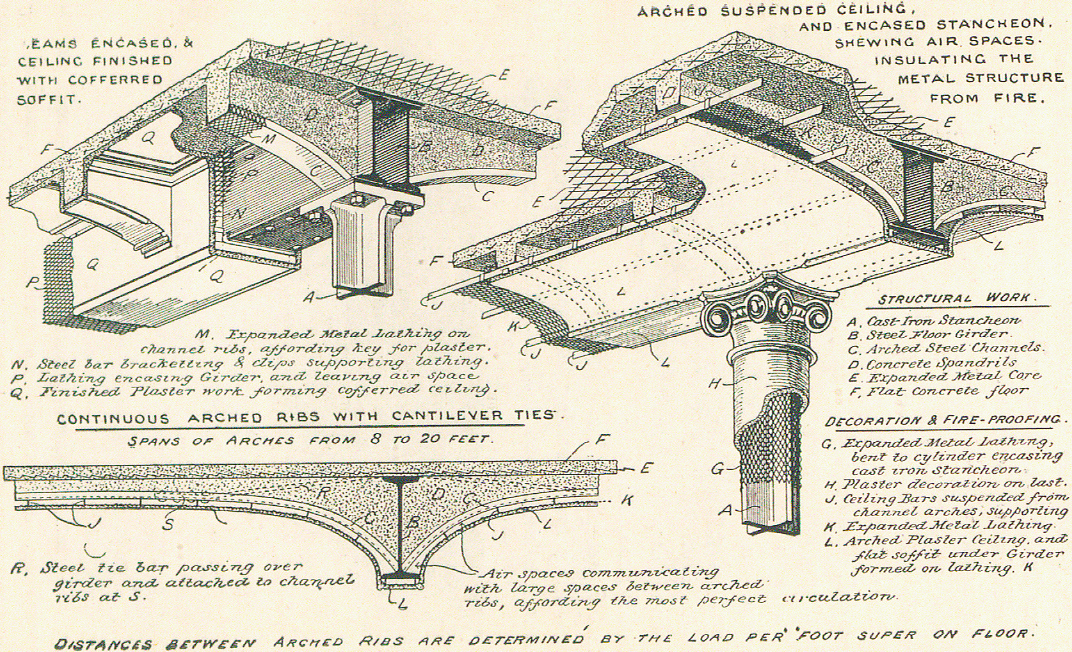
equal to any practical demands. The combined steel and plaster work forms a monolithic slab which will withstand a pressure or thrust that would break down any ordinary plaster partition. **There is no possibility of shrinkage or the falling off or cracking of the plaster. The space economised** by the employment of these partitions in buildings, as compared with brick walls, is obviously considerable. During the year 1895 more than 300,000 yards of these Expanded Metal and plaster structures were constructed in the leading cities of the United States.

"EXPANDED METAL" AS A COVERING FOR BEAMS AND COLUMNS.

The covering of beams, girders, and columns with Expanded Metal ready to receive plaster is usually a simple matter, although the precise methods to be adopted vary according to conditions, or instances presented. Wooden lathing is excluded in fire-proof constructions, metal furring, &c., being only accepted. Many thousands of yards of our metal have been used for these protective purposes. The peculiar structure of Expanded Metal enables the accomplishment of special forms or shapes which are not readily obtainable by the use of any other material.

In many instances the column is simply wrapped with our metal, and the plaster applied thereto. A better system is to use some form of metal furring strips to separate the lathing and plaster from the column.

Fig. 5 represents a simple way of employing Expanded Metal for boxing in beams or girders where wooden floors or concrete slabs are laid on the top. This may be accomplished in a variety of ways as to furring.



,EAMS ENCASED, & CEILING FINISHED WITH COFFERRED SOFFIT.
M. Expanded Metal Lathing on channel ribs, affording key for plaster.
N. Steel bar bracketting & clips supporting lathing.
P. Lathing encasing Girder, and leaving air space
Q. Finished Plaster work forming cofferred ceiling.
ARCHED SUSPENDED CEILING, AND ENCASED STANCHEON, SHEWING AIR SPACES INSULATING THE METAL STRUCTURE FROM FIRE.
STRUCTURAL WORK.
A. Cast-Iron Stancheon
B. Steel Floor Girder.
C. Arched Steel Channels.
D. Concrete Spandrils
E. Expanded Metal Core
F. Flat Concrete floor
DECORATION & FIRE-PROOFING.
G. Expanded Metal Lathing, bent to cylinder encasing cast iron Stancheon.
H. Plaster decoration on last.
J. Ceiling Bars suspended from channel arches, supporting
K. Expanded Metal Lathing.
L. Arched Plaster Ceiling, and flat soffit under Girder formed on lathing. K
CONTINUOUS ARCHED RIBS WITH CANTILEVER TIES.
SPANS OF ARCHES FROM 8 TO 20 FEET.
R. Steel tie bar passing over girder and attached to channel ribs at S.
Air spaces communicating with large spaces between arched ribs, affording the most perfect circulation.
DISTANCES BETWEEN ARCHED RIBS ARE DETERMINED BY THE LOAD PER FOOT SUPER ON FLOOR.

PLATE F.

Fig. 6 indicates a somewhat elaborate furring arrangement for girders which project below tile or such like floors. The design as shown is intended to represent an ornamental and massive plaster beam to correspond with the columns. The method employed, while simple, is strong and secure.

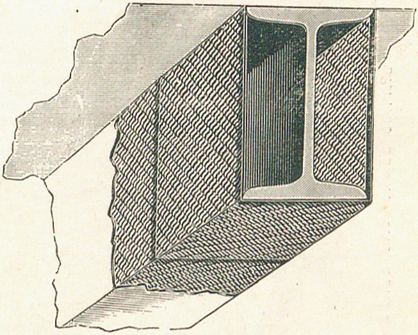


Fig. 5.

The illustrations given on **Plate F** (preceding page) further represent the manner in which our lathing may be satisfactorily employed for obtaining fire-resisting decorations and protections for beams, columns, and ceilings. Cast-iron stanchions, covered

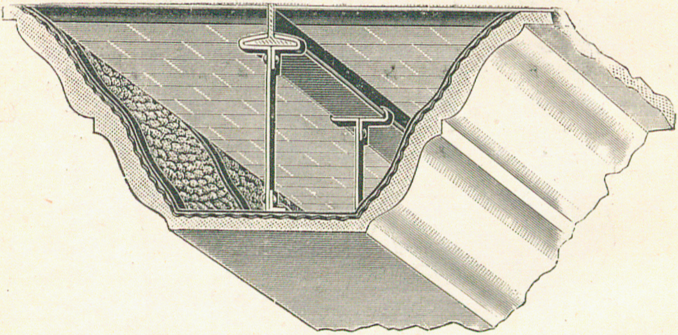


Fig. 6.

by the lathing and plaster, are represented in this engraving, but it will be evident that practically any description or section of column may be similarly encased, with or without the intervention of metal furring strips.

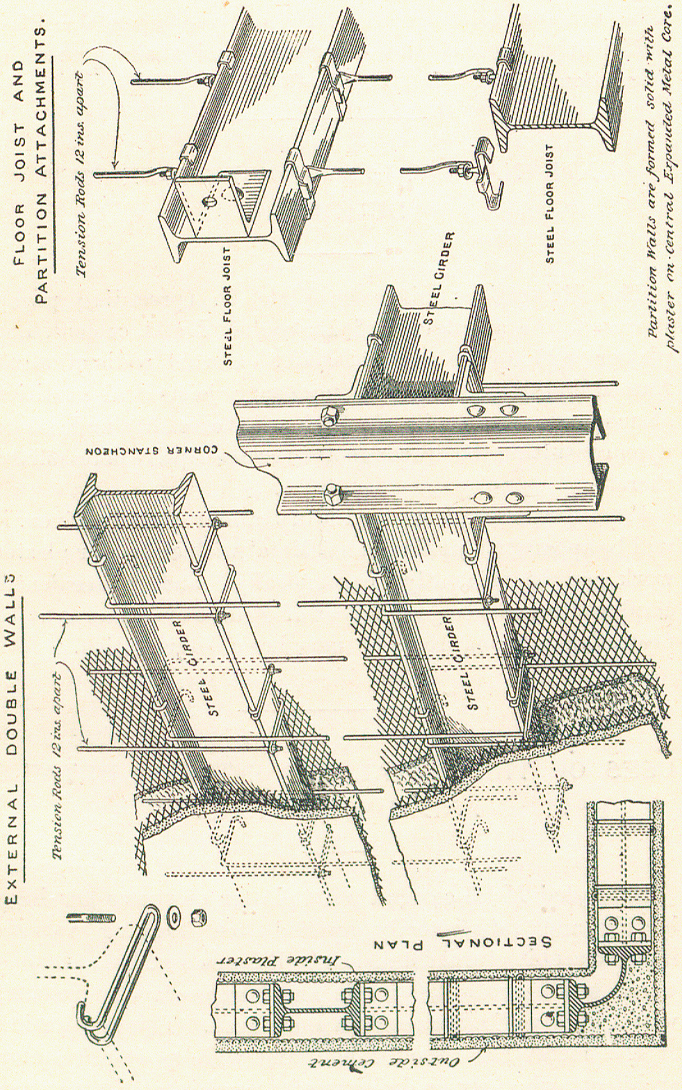

FLOOR JOIST AND PARTITION ATTACHMENTS.
Tension Rods 12 ins. apart
STEEL FLOOR JOIST
STEEL GIRDER
STEEL FLOOR JOIST
Partition Walls are formed solid with plaster on central Expanded Metal Core.
CORNER STANCHEON
EXTERNAL DOUBLE WALLS
Tension Rods 12 ins. apart
STEEL GIRDER
STEEL GIRDER
SECTIONAL PLAN
Inside Plaster
Outside Cement

PLATE G.

The notes and letters of reference given upon the Plate sufficiently explain the structures and their process of formation.

EXTERNAL WALLS OF STEEL-FRAMED BUILDINGS.

The illustrations given on plate G, (preceding page), represent the adaptation of Expanded Metal, cement, and plaster work to the construction of external walls of steel-framed buildings with the necessary joists and partition attachments, the details of which will be readily understood upon consulting the drawings and the descriptive notes affixed thereto.

From the descriptions and illustrations already given, it will be apparent that Expanded Metal with cement or plaster work can be efficiently, economically, and conveniently employed for encasing any types of girders or beams so as to protect them from fire and atmospheric deterioration.

USES OF THE METAL FOR INTERIOR DETAILS AND DECORATIONS.

Expanded Metal covered with plaster or stucco has been largely and satisfactorily applied for forming various interior architectural details, embellishments and ornamentations, which are alike simple and inexpensive to execute, whilst highly effective results are achieved. This application of the metal has revealed new and wide possibilities for architects who may be desirous of economising, or who are restricted in matters of such disbursements. **It has been**

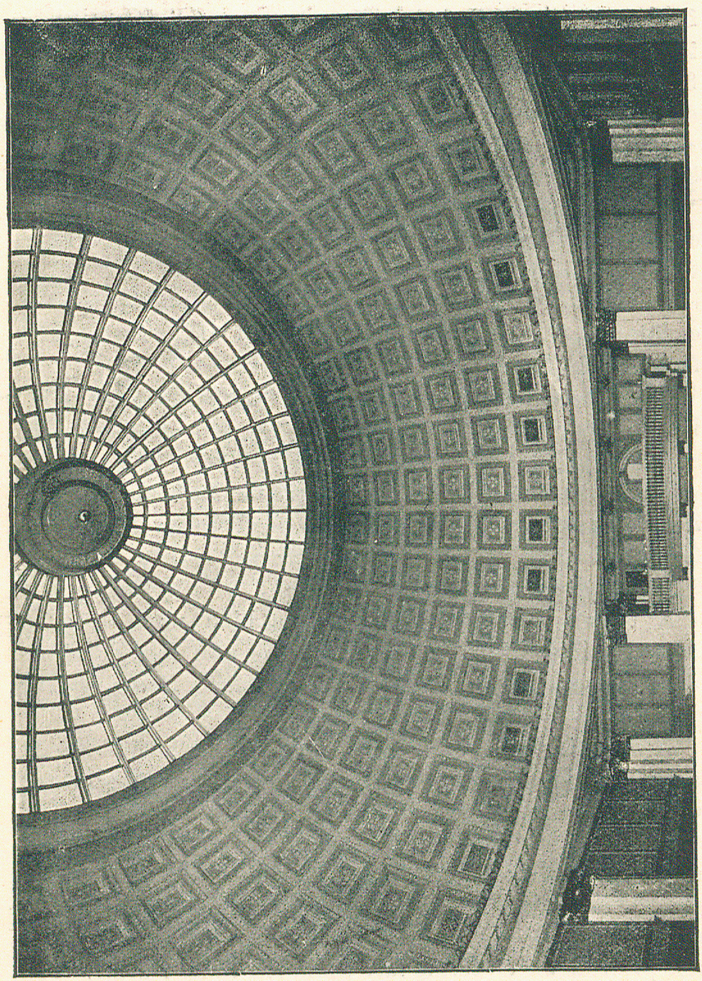
already largely used, for such or like purposes, in many of our London and Provincial Theatres, Music Halls, Hotels, Banks, Libraries, Mansions, and Public Buildings. The domed plaster ceiling of the new Royal United Service Institution, Whitehall, is formed and moulded upon our metal lathing. A list of some of the buildings in which our metal has been employed will be found at the end of this book.

By this system of construction, elaborate and artistic ceilings, pilasters, columns, groins, coves, panels, &c., have been formed for the adornment of churches and other important edifices, the designs in some cases being in relief or intaglio; in others the employment of mosaics, tiles, and fresco works have formed elegant features.

It will be understood that the strands of the meshed metal form a natural series of trusses possessing high degrees of stiffness or rigidity, which is much augmented upon the application of the plaster, which **it never fails to securely hold in position.** The fabric can be cut and readily bent to follow practically any required contours that may form the basis of a decorative design.

A typical exemplification of the kind may be cited in connection with the construction of the domed ceiling which is erected in the New York Clearing House, and as represented in Fig. 7, (overleaf)

This institution, which was opened last year, is the financial centre of the banking interests of this metropolis of the United States. Its cost of construction, in all probability, represents a larger sum per cubic foot of space occupied than any other public building] on that continent. Although nearly 100 ft. to the summit of its handsome dome, it occupies less than 10,000 square ft. of ground space. Its front exterior presents an elaborate face of carved white marble. The interior, with its twenty rooms, is very artistic. All the panelled ceilings, coves, groined arches, and domes are the product of the latest skill and knowledge in the plastic art.



DOMED CEILING OF THE NEW YORK CLEARING HOUSE CONSTRUCTED UPON EXPANDED METAL.

FIG. 7.

The effective dome in the Clearing Room was built on the sure foundation of a metal framing, sheathed with Expanded Metal. There are graceful ceilings in the other rooms, which were accomplished in the same manner.

The useful qualities of the fabric when used in plastic materials have been appreciated and utilised by tile and mosaic workers. It has been found an advantage to embed sheets of Expanded Metal in the cement, which form the foundation for their materials. They find that this prevents any sagging or breaking of bonds in their work.

In any description of the structures in point it can be emphatically stated that **not so much as a single instance has occurred wherein the metal has failed to faithfully hold the mortar or plaster in its place.** It is in this desirable property that the very essence of its merits exists The sole purpose and object of lathing is to hold the plaster in position. It may, therefore, be truthfully urged that **ours is the best form of lathing to employ** under any and all conditions. Millions of yards of this metal have been used for ceilings and like structures, and it has never been charged with a failure to perform its designed purpose. It has held the cement or mortar against the ravages of fire, the injurious effects of water, and the jars of trucks and loads in warehouses.

The effectual manner in which the plaster imbeds and keys itself within the meshes of the Expanded Metal lathing may be more thoroughly appreciated upon reference to Fig. 8, which represents an exterior view of an arched or curved ceiling constructed according to our system as described.

Fig. 9 explains the manner in which our lathing is applied and secured to ceiling frames and beams so as to form the foundation and key for the decorative plaster work. Any desired contours may be followed, and the resulting construction may have a very massive and elegant appearance.

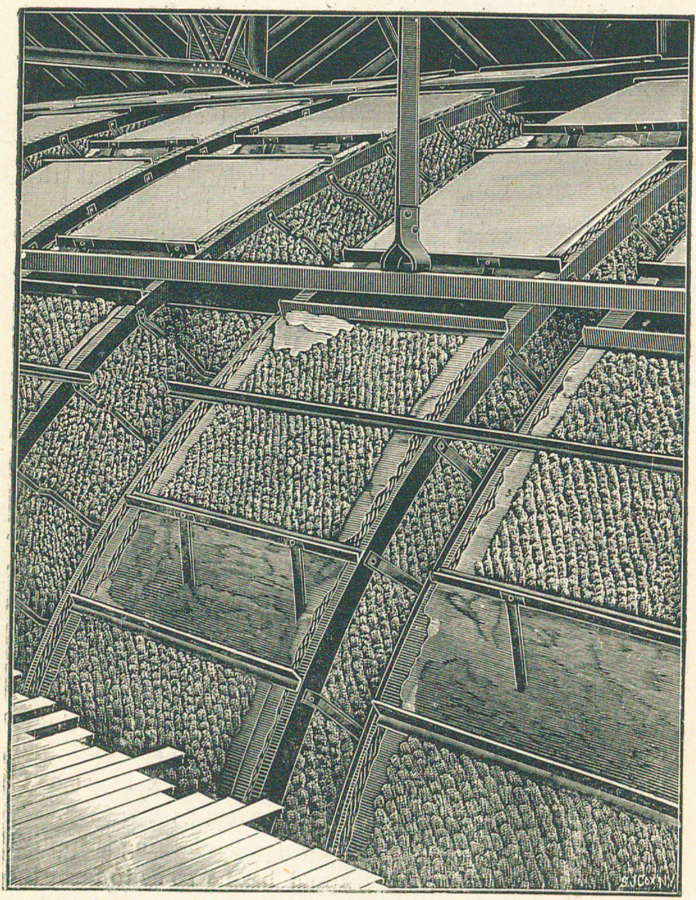


FIG. 8.—AN EXTERIOR VIEW OF OUR METAL LATH-AND-PLASTER CEILING WORK.

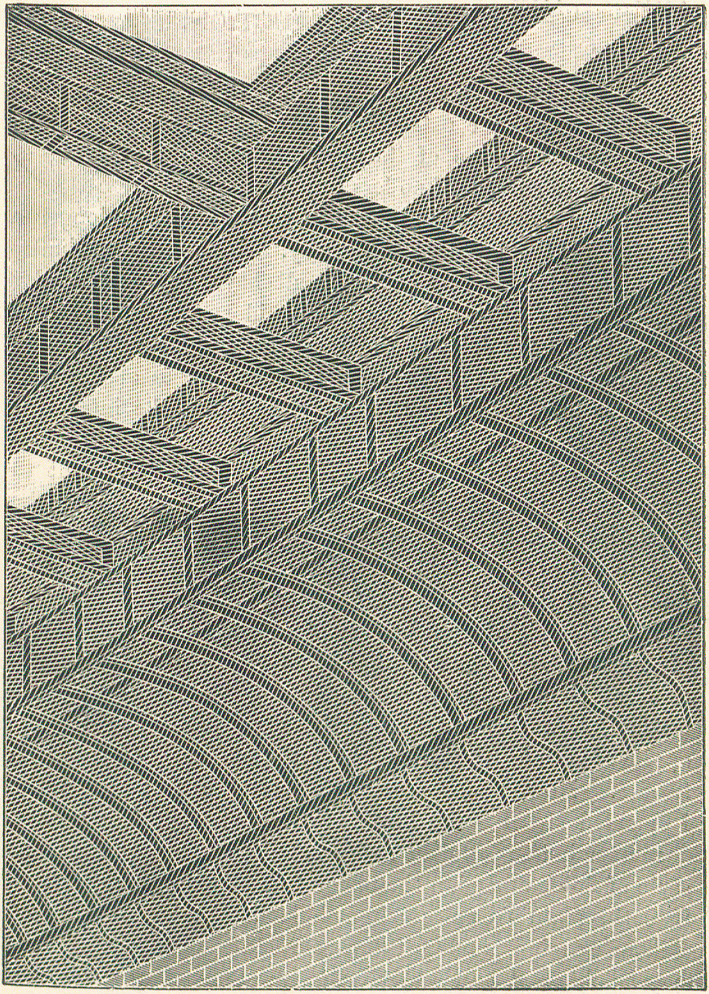


FIG. 9.—THE METAL AS FIXED TO CEILING FRAMES AND BEAMS FOR RECEIVING PLASTER.

THE METAL IN EXTERIOR, OR CEMENTINE, HOUSE CONSTRUCTION.

Sufficient has been stated concerning the uses of Expanded Metal for interior constructions. We will now pass on to briefly consider some of its applications to the exteriors of buildings—a subject of no less importance.

Exterior constructions in cement or stucco are no longer a novelty to the building fraternity. Its use is gradually creeping in for treating gables, small bays, and occasionally upper stories of some suburban residences. Several considerations have delayed the more general introduction of this system. In the first place, the advantages of the construction have never been properly put before the interested public. Again, in the earlier uses, and before the introduction of metal lathing, it was difficult to get the cement to stay in position. Another difficulty was the fact that the plasterer did not understand the proper application of cement so as to secure the desired effect to the eye as well as the lasting qualities of the material itself.

The principle of exterior cement constructions is hundreds of years old, and such work has often withstood the deteriorations of time better than some natural stones. The old method, however, required a base of brickwork for the application of the cement, or the use of wooden frames. Now, upon a suitable metallic framework the Expanded Metal is fixed in horizontal sheets. The cement or mortar is then applied and worked to represent whatever style of finish or design the taste of the architect may desire. Smooth, plain trowel work, pebble dash, stippled or more elaborate designs, and imitations of rock-faced stonework, &c., may be obtained, so that it is difficult, if not impossible, for the ordinary observer to detect the clever counterfeit. The amount of ornamentation which this construction may be subject to is only limited by taste and cost.

FIG. 10.—HOUSE CONSTRUCTED OF EXPANDED METAL AND CEMENT.

Economy is one of the chief features which recommend the system. A building having the structural beauty and effect of solid stone can be erected at **about one-third the cost** of the former. Another advantage is the house will be warmer in winter and cooler in summer, more free from moisture than in either brick or stone structures, and yet prove equally fire-proof. This last point is a very important one, and it is known that mortar, more particularly with cement as a constituent, is an excellent non-conductor of heat. When this plastered surface is held in place by Expanded Metal, it is almost impossible for fire to penetrate it.

The preceding illustration, Fig. 10, is a reproduction of a photograph of the residence of F. Tiedeman, Esq., St. George, Staten Island, N.Y., which is constructed according to the method above described. **The entire exterior of this structure** except the roof and foundation, iron railing and window casings, **was built of Portland cement on Expanded Metal lathing.** The interior is also similarly lathed and plastered with hard mortar. The house is a work of art in cement construction, and has in every way proved a success. It has stood years of exposure, and, located as it is overlooking New York Harbour, has had a severe trial from salt air and inclement weather. **This structure has thoroughly withstood the influences of heat, cold, and all atmospheric and climatic conditions.** As an example in this country of an exterior cement construction which was built upon Expanded Metal, we may cite the lighthouse which was erected at the Naval and Earl's Court Exhibitions, as represented in our illustration, Fig. 11.

EXPANDED METAL IN RESERVOIR ROOFS.

Concrete and Expanded Metal have been used in the construction of roofs or coverings for reservoirs, tanks and similar structures. Spans up to 60 ft. have been executed to entire satisfaction. These light roofs are carried out on

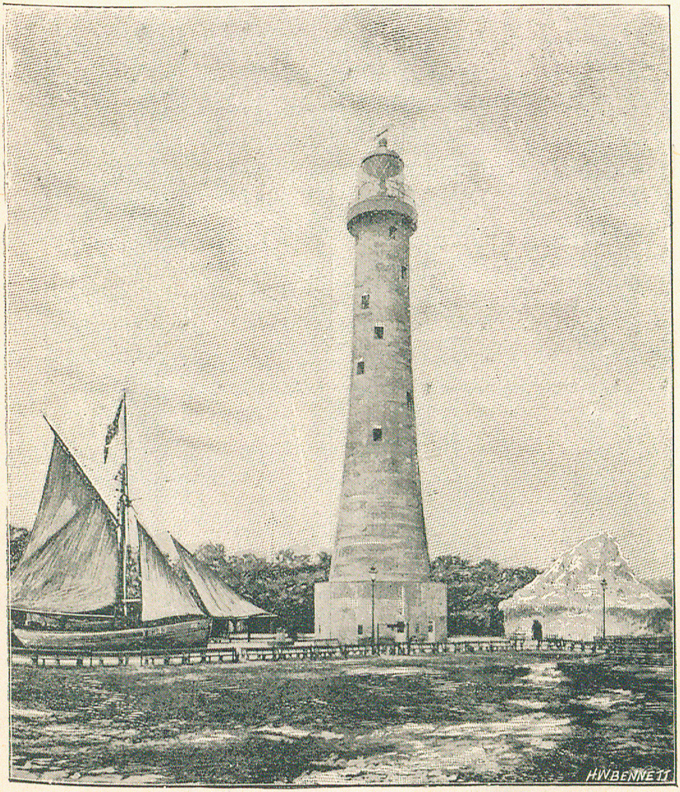


FIG. 11.—LIGHTHOUSE CONSTRUCTED OF EXPANDED METAL AND CEMENT.

the principle of our arched channel floors described in System I, and unquestionably afford the most economical and efficient means of dealing with such cases.

Continuous spans of 100 ft. and upwards may be execrted according to this method, as will be understood upon reference to **Plate H**, given on the next page.

I

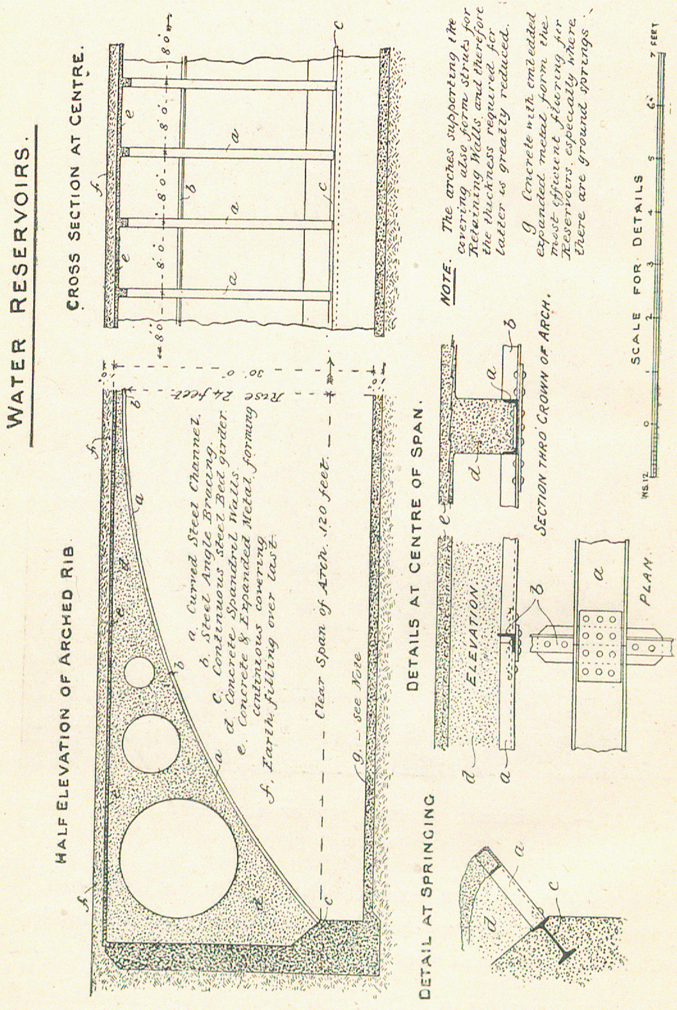

WATER RESERVOIRS.
CROSS SECTION AT CENTRE.
HALF ELEVATION OF ARCHED RIB
a. Curved Steel Channel.
b. Steel Angle Bracing.
c. Continuous Steel Bed girder.
d. Concrete Spandril Walls.
e. Concrete & Expanded Metal forming continuous covering.
f. Earth filling over last.
Rise 24 feet.
Clear Span of Arch. 120 feet.
g. - see Note
DETAILS AT CENTRE OF SPAN.
ELEVATION.
PLAN.
SECTION THRO' CROWN OF ARCH.
DETAIL AT SPRINGING
NOTE. The arches supporting the covering also form struts for Retaining Walls, and therefore the thickness required for latter is greatly reduced.
g. Concrete with embedded expanded metal form the most efficient flooring for Reservoirs, especially where there are ground springs.
SCALE FOR DETAILS
7 FEET

PLATE H.

When the widths of such tanks are comparatively small, they may be spanned by straight girders, placed, say, 6 ft. apart, and covered by a continuous concrete slab, similar to the system explained with reference to Plate B.

In the foregoing pages we have endeavoured to explain some of the ways in which Expanded Metal has been advantageously used in building operations during the last few years. We have only referred to some prominent examples, but we hope and believe that enough has been stated and shown in order to demonstrate its satisfactory position in fire-proof constructions. We therefore feel justified in announcing that we are prepared to estimate for or execute any work within our field of production and operations with every confidence of giving entire satisfaction.

SOME MINOR STRUCTURES.

EXPANDED METAL IN ELEVATOR AND VENT SHAFTS.

Passing reference may now be made to a few examples of minor constructions, in which the uses of Expanded Metal have played efficient and important parts. The merits of our solid partition constructions have found acceptance in the way of shaft buildings for elevators and in the formation of ventilating, light, air, and shafts of all kinds. The space occupied by the walls of such structures is always valuable, and hence the desirable features of a construction for these purposes are a small total thickness combined with strength and fire-resisting qualities. Where lift, light, and vent shafts are required in buildings for kitchen and other services, this class of structure is worthy of notice. In practice, these shafts are built of stiff angle iron framings at the corners and door openings as indicated in the accompanying illustration, Fig. 12. In some cases heavier channel sections are used for the latter purpose. The intervening walls may be of $\frac{3}{4}$ in. channels with the metal lathing securely wired on, and the whole plastered in good style with one of the cements or hard mortars.

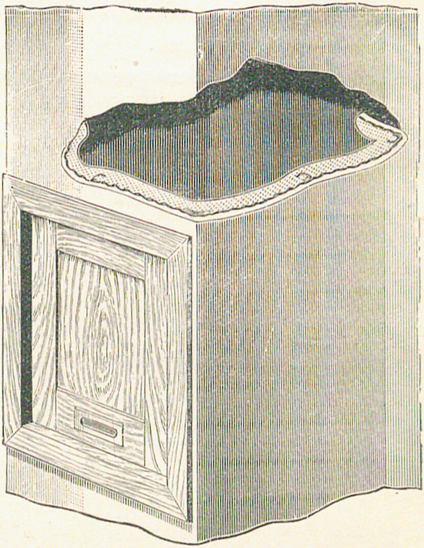


FIG. 12.

FOR COVERING HOT-AIR AND OTHER PIPES.

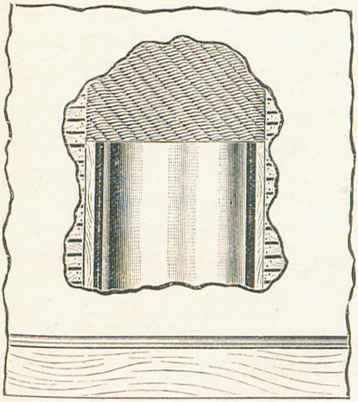


FIG. 13.

In some buildings hot-air, steam, or like pipes require to be placed within the walls. A considerable degree of safety is added to these arrangements by the use of Expanded Metal fixed over the parts thus exposed to unusual heat. It further prevents any cracking of the plaster, which commonly occurs when wood lathing is used. The illustration Fig. 13 represents how neatly and efficiently this may be accomplished.

In this connection it should be stated that a wise precaution is effected by the introduction of Expanded Metal and plaster over and near the location of hot-air, &c., furnaces in basements.

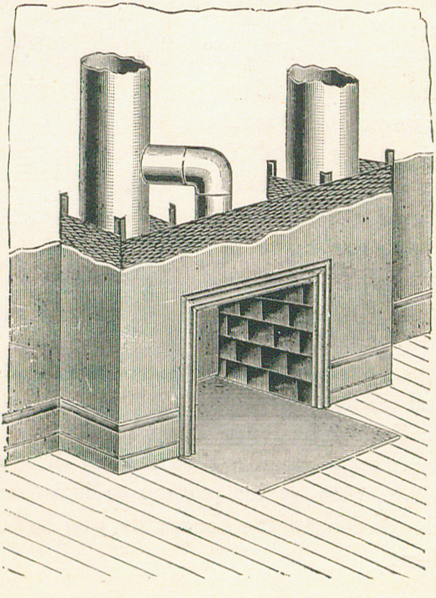


FIG. 14.

FIRE-PROOF FLUES & SMOKE STACKS.

The accompanying illustration (Fig. 14) shows a method of fire-proofing flues, smoke stacks, and metal chimneys &c. The shafts

may be placed alongside an outer brick wall, and about this a fire-proof casing can be built of metal furring, expanded lathing, and cement. The envelope may be built of sufficient area to allow of a large air chamber being formed all about the chimney.

THE METAL IN WINDOW SILLS.

Concrete slabs containing Expanded Metal have been successfully used in the production of window-sills and like structures in place of the employment of stone for such purposes.

THE LATHING IN THE CONSTRUCTION OF BATH ROOMS, CLOSETS, &c.

Fig. 15 represents the employment of our solid partitions in toilet, bathrooms, lavatories, closets, &c. In this class of work the cement or mortar used is trowled down to a glazed finish, which gives a result equal in durability to marble or slate at much less cost. The system of separating the floors and ceilings from the partitions or compartments has also been used in dividing up wards in hospitals, thus giving privacy or isolation, as well as complete ventilation, to the occupants, and facilities for cleansing the floor.

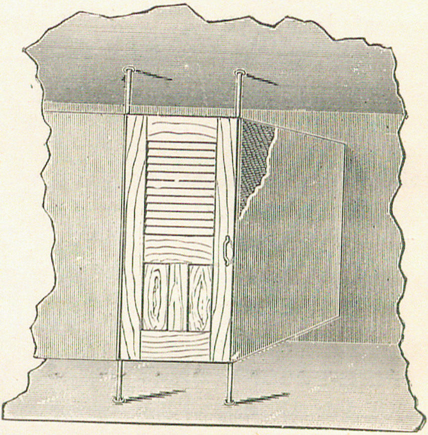


FIG. 15.

THE METAL IN MAKING SCHOOL, &c., BLACKBOARDS.

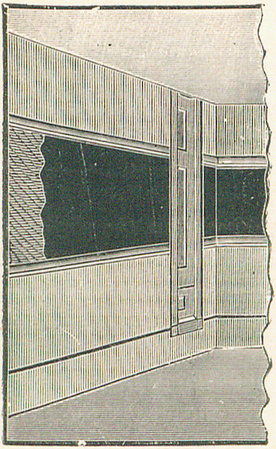


FIG. 16.

Expanded Metal has been advantageously applied to the mounting of artificial blackboards so as to secure a base upon which to fix the slab, which shall be free from cracks caused by shrinkage or splitting of the background itself. This has been successfully accomplished by the use of Expanded Metal (Fig. 16), which is securely attached to furring strips. This method ensures setting the board free from the influences of moisture or other ill effects which may result from the wall.

EXPANDED METAL IN SIDEWALK CONSTRUCTIONS.

A system of street sidewalk construction, in which Expanded Metal is well utilised, is shown by the illustrations (Figs. 17 and 18). It is practically the same as our floor System No. 1, previously described, with the exception that the slab of concrete is heavier and the top surface finish is richer in cement. This construction costs much less than the use of stone. It is also stronger and does not wear smooth and slippery like stone. The continuous lower surface renders it impervious to water, and needs no caulking. If desired, the under side may be plastered —for utilising the spaces in connection with the basements of buildings. This class of sidewalk has been constructed in spans from 10 ft. to 16 ft.

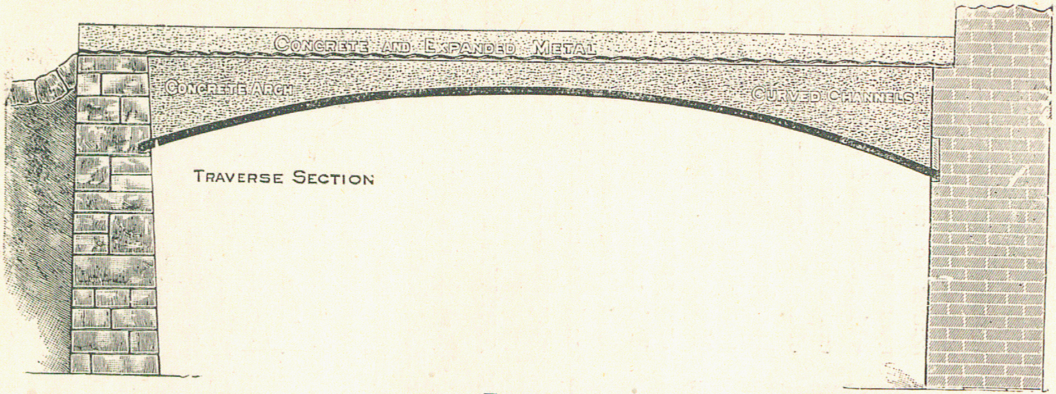


FIG 17.

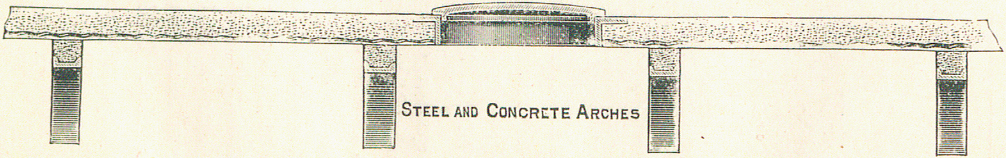


FIG. 18.

EXPANDED METAL AND CONCRETE IN SIDEWALKS.

EXPANDED METAL AS A SUBSTITUTE FOR WIRE-WORK.

The manifold ways in which Expanded Metal may be advantageously employed as an excellent substitute for various descriptions of wire-work fabrications have already been emphasised in the preface of this little treatise. Therefore, we only now propose to direct the reader's brief attention to a few of its salient applications concerning this branch of industry.

Fig. 19 represents a sheet of expanded steel, formed with a straight top selvage edge, secured to common wooden posts by means of staples. This will be seen at a glance to con-

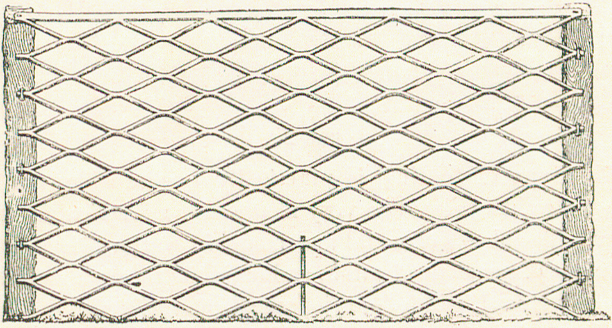


FIG. 19.

stitute a cheap, efficient, and strong fence for enclosing farms, estates, railways, &c. Obviously, no skilled labour is required for its erection.

The illustration given in Fig. 20 represents a similar application of an expanded sheet of like metal, with the exception that the major axes of the meshes are placed and fixed vertically within a metal frame, instead of lengthwise between posts as shown in the preceding engraving.

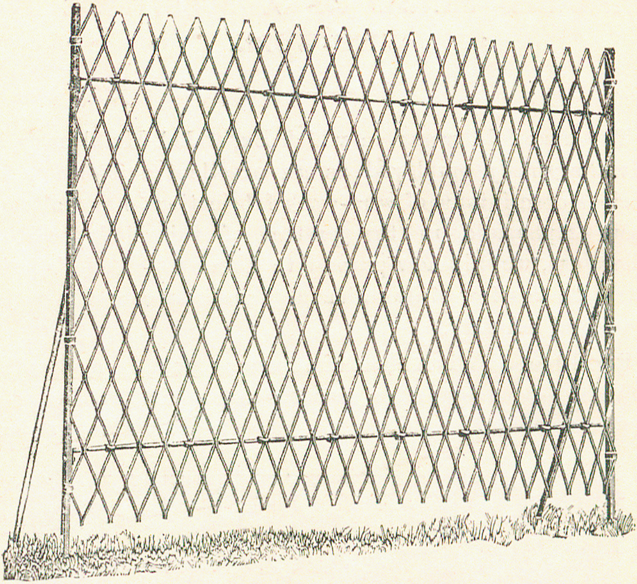


FIG. 20.

This type of fencing is practically unclimbable, and at the same time presents a very neat and symmetrical appearance. The sheets of metal are made in various sizes, with different dimensions of mesh, as hereinbefore explained, and are galvanised, painted, or japanned, according to taste or requirements. The use of metal or wooden posts is a matter of selection, and in both cases the sheets may be attached without the aid of special tools or skilled labour.

Manifestly the metal may be similarly employed, in a large variety of forms and mountings, so as to be peculiarly suitable for the construction of bowers, arches, tree-guards, trellis work, "espalier" training fences, garden borders, basket and flower stands, &c.; also for aviaries, dog kennels, sheep and poultry runs, farmers' hurdles, &c. It may here be mentioned that our 6 in. mesh is strong enough to restrain and turn any class of cattle.

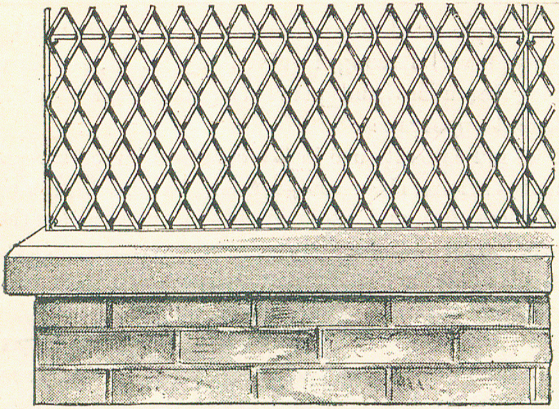


FIG. 21.

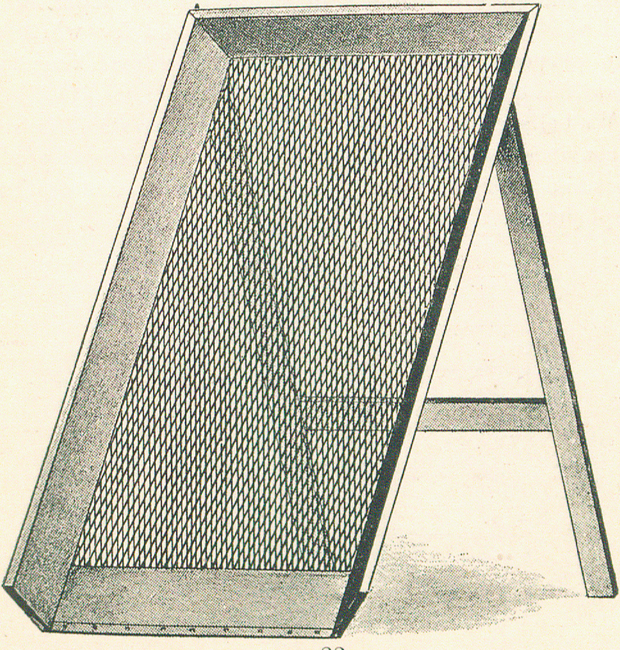


FIG. 22.

PARAPET FENCING AND SCREEN MADE OF EXPANDED METAL.

An example of the application of Expanded Metal to parapet and wall fencing is given in Fig. 21, which, whilst excluding intruders and preventing accidents, is of strong and elegant appearance.

Fig. 22 indicates its use in the construction of screens and sieves of various sizes and forms. In the fabrication of window, door, fire, and other guards it presents another extensive scope for useful and appropriate application, as also in respect of numerous other articles as manufactured in the wire-workers' trades.

In the Introductory Chapter we mentioned that **Expanded Metal is also manufactured at our works from sheets of brass, aluminium, and other metals** for fancy and special structures. We would here accentuate the economical uses of our **lacquered brass fabrics** for the production of fire and window guards, desk railings, &c., and for which and like purposes we have supplied, and are furnishing, large quantities of this form of our metal.

We believe that sufficient has now been stated in order to convince the reader of the valuable nature of our productions and their enormously wide field of useful and profitable employment.

Tables Showing Safe Live Loads (¼ Estimated Breaking Strengths) on our Fire-Proof Floors.

TABLE I.—3 inch Slabs

Safe Live Load per foot super: breaking load 4 times this.	Limiting span of concrete slab for safe load.	Load per foot run on joists (if required) including weight of floor.
Cwts.	Feet.	Cwts.
1	6.97	8.78
1¼	6.24	9.42
1½	5 65	10.01
1¾	5.27	10.59
2	4 93	11.14
2¼	4.65	11.67
2½	4.41	12.17
2¾	4.20	12.64
3	4 03	13.14
3¼	3.86	13.55
3½	3 72	13.99
3¾	3.60	14 44
4	3.49	14.87
4¼	3.38	15.24
4½	3.28	15 61
4¾	3.20	16.03
5	3.12	16.41

To increase the spans, add to the thickness of slab and weight of Expanded Metal.

TABLE II.—ROLLED STEEL JOISTS.

Depth.	Width.	Weight per ft.	Safe Loads in Cwts. per foot run, equally distributed on undermentioned Spans; being One Quarter of the Breaking Loads ascertained from Tests of the Steel.																			
In.	In.	Lbs	6ft.	7ft.	8ft.	9ft.	10ft.	11ft.	12ft.	13ft.	14ft.	15ft.	16ft.	17ft.	18ft.	19ft.	20ft.	22ft.	24ft.	26ft.	28ft.	30ft.
3½	×1½	6	4.91	3.61	2.76	2.18	1.77															
4	×1¾	8	7.63	56.1	4.30	3 39	2.75	2 27	1.99													
4	×3	9.5	11.16	8.20	6.28	4.96	4.02	3.32	2.78	2 37												
5	×3	11	16.16	11.88	9.09	7.18	5.82	4.81	4.04	3.44	2.97	2.58										
6	×3	13	20.50	15.06	11.53	9.11	7.38	6.10	5.12	4.36	3.76	3.28	2.89	2.55								
6	×3	16		18.24	13.97	11.03	8.94	7.39	6.21	5.29	4.56	3.97	3.49	3.09	2.76							
7	×3¾	18			19.98	15.79	12 79	10.57	8.88	7.50	6.52	5.68	4.99	4.42	3.95	3.54	3.19					
8	×4	19				1 859	15.06	12.44	10.46	8.91	7.68	6.69	5.88	5.21	4.64	4.17	3.76	3.11	2.61			
9	×3¾	20					17.78	14.69	12.34	10.52	9.07	7.90	6.94	6.15	5.48	4.92	4.44	3.67	3.08	2.63		
10	×5	29						24.97	20.98	17.88	15.41	13.43	11.80	10.45	9.32	8 37	7.55	6.24	5.24	4.47	3.85	
10	×5	35									17.41	15.16	13.33	11.81	10.53	9.45	8.53	7.05	5.92	5.04	4.35	
12	×5	32										17.45	15.34	13.59	12.12	10.88	9.82	8.11	6.82	5.81	5.01	4.36
12	×5	39											17.67	15.65	13.96	12.53	11.31	9.34	7.85	6.69	5.77	5.03
13	×5	41.5												17.06	15.22	13.66	12.33	10.19	8.56	7.29	6.29	5.48
14	×6	46													19.87	17.83	16.09	13.30	11.17	9.52	8.21	7.15
15	×5	42													8.19	16.33	14.74	12.18	10.23	8.72	7.51	6.55
15	×6	59															21.94	18.13	15.23	12.98	11.19	9.75
16	×5	50																15.33	12.88	10.97	9 46	8.24
16	×6	62																19.89	16.72	14.24	12.28	10.70
18	×7	75																		20.17	17.39	15.15
20	×7½	89																				19.50

Use of the Tables.—The required live load and the span being known, refer to *Table I.* for limiting safe span of concrete and Expanded Metal slab. If the required span exceeds that given in second column, supporting joists will be required at intervals equal to the limiting span. To find the proper section for such joists, note the load per foot in third column of Table I.; refer to the column in Table II. corresponding with the required span, and select the joists capable of supporting that weight per foot run.

The heavy step-like line in Table II. indicates the Greatest Spans for which Joists should be used (owing to deflection) where Plaster Ceilings are to be attached.

The following list incorporates the names of some of the Chief Buildings, Works, and Places in which EXPANDED METAL has been employed within the UNITED KINGDOM in connection with structural, decorative, fencing, or like works. In addition, it may be mentioned that THE METAL has also been extensively exported to, or similarly used in, India and our Colonies, Europe, Asia, Africa, and North and South America :—

H.M. War Office.
H.M. Post Office Savings Bank Department.
London County Council Works.
London and Westminster Bank.
Bank of Scotland.
Guy's Hospital.
Lord Rothschild's Mansions, Tring, Herts.
Hotel Avondale, Piccadilly.
Trocadero Restaurant, Piccadilly.
London & South Western Railway.
Midland Railway.
The Royal United Service Institution, Whitehall.
The New Travellers' Club, Pall Mall.
Lord Rosebery's Mansion, Berkeley Square.
Lyceum Theatre.
Drury Lane Theatre.
Baths Club, Piccadilly.
East London Mission to Seamen.
Theatre Métropole, Camberwell.
People's League, Peckham.
Jones and Higgins, Peckham.
East Dulwich Letter Sorting Office.
South Norwood Post Office.
Harvey and Nicholls', Knightsbridge.
Cotton Mills in the Lancashire District.
Brompton Fire Station.
Carnaby Street Electric Light Station.
Walham Green Schools.
St. Mary's Schools, Mill Hill.
Yattendon Schools.
Sanger and Sons, Winsley Street.
Erard and Co., Great Marlborough Street.
New London Music Hall.
Prescott's Bank, Limited.
"Lloyd's News" Premises.
"Constantinople in London."
Theatre Royal, Paisley.
Griffin Music Hall, London.
Tivoli Theatre, London.
Gaiety Theatre, London.
Trafalgar Theatre, London.
Daly's Theatre, London.
Oxford Music Hall, London.
New Olympic Theatre, London.
Olympia, London.
South London Palace, London.
Royal Aquarium, London.
Prince's Hall, Piccadilly, W.
Lincoln Theatre.
Bedford Grammar School.
Royal Naval Exhibition, Lighthouse.
Peckham Public Hall.
Peckham Free Library.
H.M. Office of Works.
Great Northern Railway Co.
Great Eastern Railway Co.
Star Life Insurance Co. Office.
New "Globe" Printing Office.
"Morning Post" Office.
City Bank, London.
Wandsworth Road Fire Station, London.
Thorney Mills, West Drayton.
Argus Printing Co.
Bermondsey Settlement.
Metropolitan Insurance Co., London.
North British and Mercantile Insurance Co., London.
City of London Electric Light Station.
New Civil Service Stores, London

Taplin & Co., Wood Street, E.C.
Mappin Bros, Cheapside, E.C.
Peter Robinson, Oxford Street, W.
Eynsford Paper Mills, Kent.
Jay's Mourning Warehouse.
Berner's Estate.
"Kingswood," Sydenham Hill.
Poyle Mill.
Sir Ed. Walters' House, Blandford.
St. Peter's House, London, E.C.
Lord Baseman's Estate.
Sir Geo. H. Newnes, M.P., Mansion.
New Asylum, Whitecroft, Isle of Wight.
New Factory, Colwick, Nottingham.
Ryland's Free Library, Manchester.
Royal Exchange, Manchester.
Ship Canal Warehouses, Manchester
Whitworth Art Galleries, Manchester.
Salford Technical Schools, Manchester.
Langworthy & Co's. Mills.
Oldham Free Library.
Corporation Baths, Cheetham.
Corporation Library, Gorton.
Stockport Ring Spinning Mill.
Diocesan Training College, Derby.
New Workhouse, Lancaster.
Willoughby Asylum Extension, Hull.
New Military Barracks, Scarboro'.
New "Chronicle" Office, Newcastle-on-Tyne.
R. Middlemass & Son, Biscuit Factory, Edinburgh.
Gamble & Co's. Offices, St. Helens, Lancashire.
Messrs. Dugdale's New Warehouses, Manchester
Watkin's Tower, Wembley Park, London, N.
Messrs. Jenner's New Buildings, Princes Street, Edinboro'.
White Hart Hotel, Grimsby.
Estate Office, Lytham.
Central Buildings, Nottingham.
Co-operative Stores, Nottingham.
Co-operative Stores, Bishop Auckland.
Lyric Opera House, Hammersmith.
Messrs. Hird's New Factory, Yarm-on-Tees.
Messrs. Kents' Works, Finsbury.
Seaton Golf Club Co., Durham.
Nairn & Co.'s Linoleum Works, Kirkcaldy.
Indian Exhibition, Earl's Court.
Central Electric Lighting Station, Edinburgh.
Elephant & Castle Theatre, London.
St. Anselm's Church, Oxford Street.
Taylor, Walker & Co. Brewery, Limehouse.
Courage & Co. Brewery, Horsleydown.
Gordon Road Workhouse, Peckham.
New Merchants' Exchange, Cardiff.
Shoolbred & Co., Tottenham Court Road, London.
Clydesdale Bank, London.
Grand Theatre, Croydon.
Convent of St. Mary, Cabra Co., Dublin,
Gaiety Theatre, Dublin.
Royal Hibernian Schools, Phoenix Park.
Grand Bazaar, Balls Bridge.
"Herald" Office, Glasgow.
North British Rubber Co.'s. Warehouse, Glasgow.
Sun Fire Office, Glasgow.
Corporation Tenements, Glasgow.
Motherwell, Cottage Hospital.
Shotts, " "
Stonehouse, " "
Longrigend, " "
Kennet Wharf.
Rhymney Railway.
Lord Warden Hotel, Dover.
Engine Drivers' Lodgings, Midland Railway, Kentish Town.
Southill Estate.
Wolverhampton Corporation Works.
Middlesex County Asylum
Windsor Barracks.
Rotherhithe New Town Hall.
Derby Asylum.
Walmer Buildings, Liverpool.
New Fire Station, Carmelite Street.
Arnott & Co's New Premises, Dublin.

Lloyd's Bank, Rosslyn Hill, N.W.
School Board Offices, Liverpool.
Potters Bar Cemetery.
New Bank Halifax.
Lambert & Butler's New Premises, Drury Lane.
New Electric Stat'on, City Road.
Creywell Brewery, New Ross, Ireland.
Lamson's Factory, Canning Town.
North Eastern Bank, Newcastle.
City Hospital, Dublin.
J. S. Fry & Sons, New Buildings, Bristol.
Calder's Distillery, Bo'ness.
St. Mary's Hospital, Paddington.
New Co-operative Stores, St. Helen's.
Shakespeare Theatre, Lavender Hill.
Alterations of Morrison Street, Glasgow.
Kensington Barracks.
New Police Station, Chelsea.
Newburn (Urban District Council Works).
Sledmere Estate, York.
Fairview Asylum, Dublin.
Jews' Hospital, West Norwood.
New Nursing Home, Whitechapel.
Paris Bank, Birchin Lane.
The Albion, Bayswater Road.
Ward Jackson Park, West Hartlepool.
Truscott's Factory, Suffolk Lane.
Y.M.C.A. Institute, Glasgow.
New Observation Wards, Chester Workhouse.
Devon and County Hospital, Exeter.
Everett's Bakery, Walthamstow.
South Dock Works, Dublin.
Harrogate Corporation Works.
New Convalescent Home, Littlehampton.
Fire Station, Farringdon Road.
Grand Hotel, Birmingham.
New L. & M. Bank, Newport, Mon.
Her Majesty's Theatre.
The Louvre, Birmingham.
New Theatre, Fulham.
New Pay Office, Maidstone Barracks.
Electric Lighting Station, Chelsea.
Welsh's New Building, Piccadilly.
County Antrim Asylum.
Marlborough Music Rooms.
The New Brighton Tower, &c.
Ivy Lodge Estate, Fulham.

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